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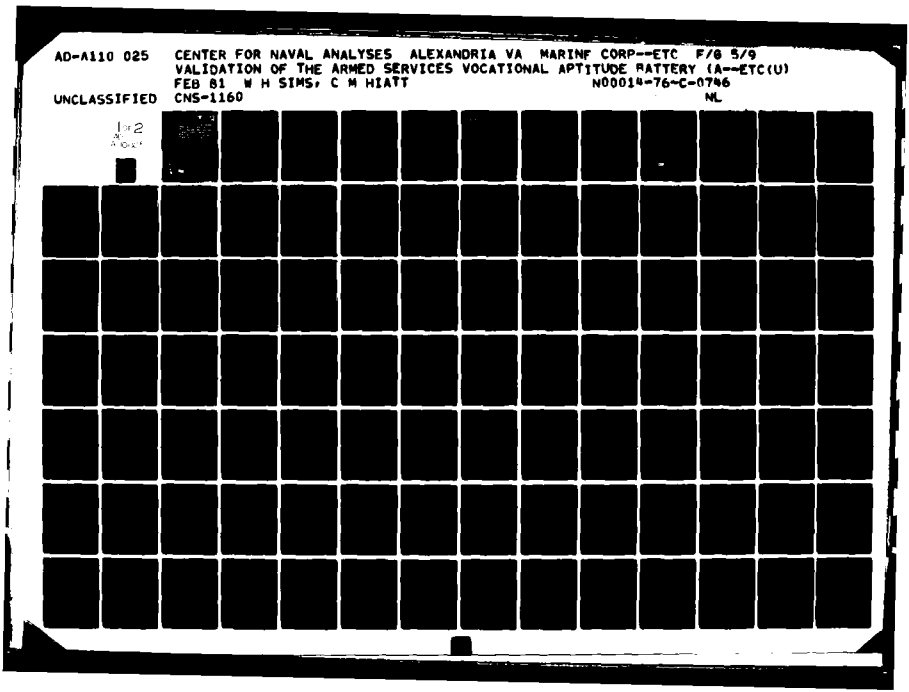

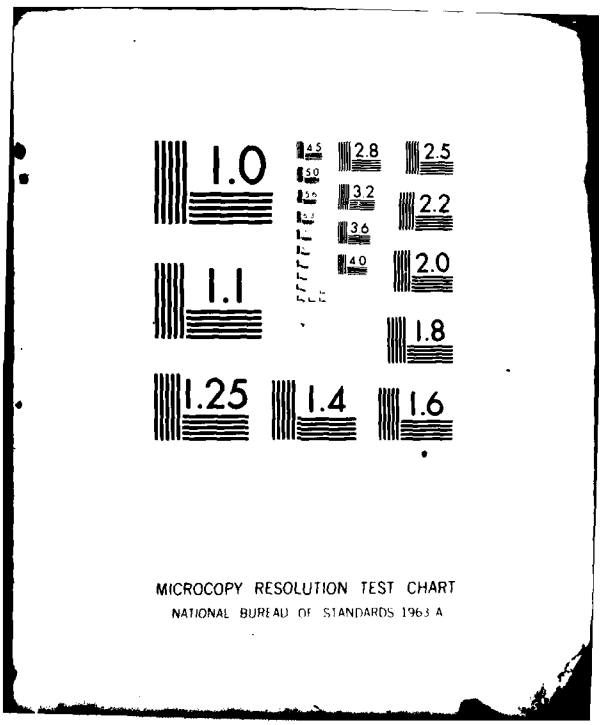
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LEVEL II

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VALIDATION OF THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) FORMS 6 AND 7 WITH APPLICATIONS TO ASVAB FORMS 8, 9, AND 10

William H. Sims
Catherine M. Hiatt

CNA

CENTER FOR NAVAL ANALYSES

Work conducted under contract N00014-76-C-0746

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

aptitude tests, ASVAB, correlation techniques, demography, factor analysis, military training, recruiting, regression analysis, schools, vocational guidance.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report examines the validity of the Armed Services Vocational Aptitude Battery (ASVAB) forms 6 and 7. Validity in this analysis is the correlation between ASVAB test scores and subsequent performance in military training courses.

Recruits are assigned to specific military training based, in part, on their scores on subgroups of tests (aptitude composites) contained in the ASVAB. We

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20 determined the most appropriate aptitude composite, and minimum acceptable score on that composite, for assignment to each training course.

ASVAB forms 6 and 7 (the source of test score data for this analyses) are compared with the recently introduced ASVAB forms 8, 9, and 10. Based on this comparison we consider the results of our validity analyses of ASVAB forms 6 and 7 to be applicable for recruit assignment using ASVAB forms 8, 9, and 10.

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2. The objectives of the study were:

a. Determination of best aptitude area composite for predicting service school completion.

b. Determination of best combination of subtests for prediction of service school composite.

c. Determination of the interrelationship of education and aptitude area composites on service school competition.

d. Determination of service school prerequisites which optimize qualified personnel available and service school competition.

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CNS 1160 / February 1981

VALIDATION OF THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) FORMS 6 AND 7 WITH APPLICATIONS TO ASVAB FORMS 8, 9, AND 10

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ABSTRACT

This report examines the validity of the Armed Services Vocational Aptitude Battery (ASVAB) forms 6 and 7. Validity in this analysis is the correlation between ASVAB test scores and subsequent performance in military training courses.

Recruits are assigned to specific military training based, in part, on their scores on subgroups of tests (aptitude composites) contained in the ASVAB. We determined the most appropriate aptitude composite, and minimum acceptable score on that composite, for assignment to each training course.

ASVAB forms 6 and 7 (the source of test score data for this analysis) are compared with the recently introduced ASVAB froms 8, 9, and 10. Based on this comparison we consider the results of our validity analyses of ASVAB forms 6 and 7 to be applicable for recruit assignment using ASVAB forms 8, 9, and 10.

EXECUTIVE SUMMARY

The armed services used the Armed Services Vocational Aptitude Battery forms 6 and 7 (ASVAB 6/7) as an enlistment screening and recruit classification test from 1 January 1976 through 30 September 1980. On 1 October 1980 ASVAB 6/7 was replaced by ASVAB forms 8, 9, and 10 (ASVAB 8/9/10). The purpose of this report is to assess the validity of ASVAB 6/7 and to make reasonable inferences about the validity of ASVAB 8/9/10. By "validity" we mean the correlation between test scores and performance in military training courses.

We make recommendations about the best ASVAB 8/9/10 composites (groups of tests in the battery) to use for selecting recruits for various training programs. We also suggest minimum acceptable aptitude composite scores for each course analyzed and make recommendations for future improvements in the formulation of composites.

It has been determined that the officially reported ASVAB 6/7 scores were inflated due to a miscalibration of the test. ASVAB 6/7 scores used in this report have been revised to reflect the correct calibration of the test. This revision ensures that an ASVAB 6/7 score (in this report) represents the same ability level as that same score will on the new ASVAB 8/9/10. For this reason, and because ASVAB 6/7 and ASVAB 8/9/10 measure very similar aptitudes, the findings of this analysis with respect to ASVAB 6/7 can be generalized to ASVAB 8/9/10.

Our findings are based primarily on an analysis of the training school performance of 26,039 Marine Corps recruits who were tested on ASVAB 6/7 and began training in CY 1977 and CY 1978. This data was supplemented by FY 1980 failure rates for 86 training courses. The validity analysis and aptitude composite selection were based on school performance as measured by the final grade achieved in the course. We used pass/fail information to estimate minimum acceptable aptitude composite scores (prerequisites). Course prerequisite levels have traditionally been stable over long periods of time. However, since 1976 two downward revisions were inadvertently made.* The downward revisions were followed by piecemeal upward corrections. In view of this instability we have taken as our point of departure the traditional (pre-1976) prerequisite levels and made such changes in these as dictated by the available information.

* These revisions were caused by the miscalibration of ASVAB 6/7 and by efforts to compensate for the underprediction, by ASVAB 6/7, of the performance of high school graduates.

FINDINGS

The findings of the analysis may be summarized as follows:

- ASVAB 6/7 was a valid test battery for the selection and classification of recruits.
- ASVAB 6/7 composites were somewhat deficient in their ability to clearly distinguish aptitudes important in various training programs (differentiation).
- The use of multiple composites as prerequisites for courses does not significantly improve the prediction of success in training. This practice does, however, greatly restrict the supply of qualified recruits and is in general, counterproductive.
- The validity of ASVAB 6/7 composites used by the Marine Corps compares favorably with that for composites used by other services.
- High school graduates outperform non-high school graduates with equivalent aptitude scores. The differential is approximately equivalent to 10 composite score points.
- ASVAB 6/7 is not biased against, i.e., does not under-predict performance of minority recruits.
- The Armed Forces Qualification Test (AFQT) part of ASVAB is a useful measure of general trainability and contains approximately 80 percent of the predictive power of the entire ASVAB.
- The AFQT could be improved as a measure of general trainability by adding the mechanical comprehension test to its formulation.
- The General Classification Test (GCT) composite used by the Marine Corps in ASVAB 6/7, and not available in ASVAB 8/9/10, may be replaced by the General Technical (GT) composite.
- Selecting aptitude composites empirically for each course by selecting the composite that correlates best with the criterion variable is unsatisfactory and leads to frequent and capricious changes in selector composites.
- A "global" approach to composite selection is preferred whereby all courses are grouped by a priori judgment into mechanical (MM), electrical (EL), clerical (CL), field

artillery (FA), combat (CO), and general technical (GT) areas and one satisfactory composite is empirically determined for each area.

- Changes in the battery from ASVAB 6/7 to ASVAB 8/9/10 should not result in any loss of predictive validity if reasonable choices of composites are made.

- The interim ASVAB 8/9/10 composites currently used by the Marine Corps are satisfactory for temporary use. The validity of the clerical composite appears to be marginally satisfactory but can be improved by adding the mathematical knowledge (MK) test to its formulation.

- The experimental set of ASVAB 8/9/10 composites we developed appears to offer improved differentiation and improved validity.

RECOMMENDATIONS

- The Marine Corps should continue to use the interim ASVAB 8/9/10 composites adopted in October 1980. However, as soon as practical, the CL composite should be changed by adding MK to its formulation. Validation of these composites should be conducted expeditiously.

- Interim ASVAB 8/9/10 composites and minimum composite scores suggested for use in all entry level courses are given in table I.

- The prerequisites shown in table I apply only to high school diploma graduates. Prerequisites for non-high school graduates should be set 10 points higher than those shown in table I.

- An experimental set of ASVAB 8/9/10 composites believed to be superior to the interim ASVAB 8/9/10 composites has been developed. It is recommended that they be explicitly evaluated in the validation of ASVAB 8/9/10. This set of composites is given in table II. It should provide better balance, differentiation, and validity than the interim set of composites.

- The AFQT score should be redefined by adding the mechanical comprehension test to its current formulation.

- The use of multiple test prerequisites (either more than one composite or one composite plus an individual ASVAB test) in the Recruit Distribution Model (RDM) should be discontinued.

- The occasional use in the AFQT of different composites as the prerequisite and as the optimizing score should be discontinued.

It should be recognized that setting minimum composite levels such as those shown in table I involves considerable uncertainty. For this reason our recommendations in table I should be viewed as reasonably accurate, but not precisely determined, points.

Efforts are currently underway to refine criteria of success with respect to training and job performance. As these efforts reach completion it is reasonable to believe that a more precise determination of minimum standards can be achieved.

TABLE I

SUGGESTED APTITUDE TEST PREREQUISITES FOR ASVAB 8/9/10

Course Title	NEC Assignment Symbol	NEC	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates[a]		Proposed Prerequisites for High School Graduates[a]	
				Mandatory	Desirable	Mandatory	Desirable
Air Traffic Controller	ABAC[b]	7311	110	GT(110)	GT(110)	GT(110), MC[c]	GT(110), MC
Advanced Base Mechanic	ABMECH	3500	-	GT(90), GM(90)	GT(90), GM(90)	MM(100), MC[c]	GT(110), MC
Air Control Electronics Operator	ACACEL	7234	100	GT(90)	GT(100)	GT(100)	GT(110)
Machinists Mate	ACMMA	6000	95	GT(95)	GT(90), GM(100)	MM(100)	MM(100)
Aerographers Mate	AEMS	6821	105	GT(90), CL(95), AR(11)	GT(100), CL(100), AR(11)	GT(110)	GT(110)
Aviation Structural Mechanic (S, H, E)	AEMH	6000	95	GT(95), GM(80)	GT(90), GM(90)	AM(100)	AM(100)
Aviation Ordnance	AOAO[d]	6500	105	GT(95), GM(95), EL(90)	GT(100), GM(100), EL(110)	GT(100)	GT(110)
Airborne Radio Operator	AORO[d]	7301	110	GT(100)	GT(110)	GT(110)	GT(110)
Aviation Support Equipment, Electrical	ASAEEL	6000		GT(95), GM(80)	GT(90), GM(100)	MM(100)	MM(100)
Aviation Support Equipment, Mechanical	ASAEM	6000	95	GT(95), GM(80)	GT(95), GM(90)	AM(100)	AM(100)
Air Support Electronics Operator	ASAESOP	7262	100	GT(90)	GT(100)	GT(100)	GT(110)
Aviation Crash Crew	ASAVCC	7051	90	GM(80)	GM(80)	MM(90)	MM(90)
Aviation Maintenance Administration	ASAZ	6046	95	GT(95)	GT(90), CL(100)	CL(100)	CL(110)
Basic Electricity and Electronics	ASBEE[d]	6300	105	GT(100), EL(90)	GT(110), EL(110)	EL(110)	EL(110)
Basic Helicopter Maintenance	ASBHEL	6000	95	GT(95)	GT(100), GM(100)	MM(100)	MM(100)
Cryogenic Equipment Technician	BECEPO	6075	100	GT(80), GM(90)	GT(90), GM(100)	MM(100)	MM(100)
NIKE Missile Fire Control Crewman	ASMFCM[e]	7200	100	GT(90)	GT(100)	GT(100)	GT(110)

TABLE I (Cont'd)

Course Title	MOS Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
[illegible] Launcher and Mechanical Systems Repair	AGEMER	5929	100	GT(95), EL(100)	GT(95), EL(100)	EL(110)	EL(110)
Aircraft Launch and Recovery Equipment	AGMALE	7011	90	GN(80)	GT(90), GN(95)	GN(90)	GN(100)
Marine Aviation Supply, Mechanized	AGMARK	3072	95	GT(85)	GT(90), CL(100)	CL(100)	CL(110)
Aviation Operations Clerk	AGMAROC	7041	95	GT(85)	GT(90), CL(100)	CL(100)	CL(110)
Missile System Maintenance Fundamentals	AGMMFC[g]	5900		GT(100), EL(110)	GT(100), EL(110), AR(11)	EL(110)	EL(110)
Aerial Navigator	AGNAV[h]	7371	110	GT(110), NE	GT(110), NE	GT(120), NE	GT(120), NE
Aircrew Survival Equipment	AGPR	6060	100	GT(90), GN(90)	GT(90), GN(100)	GN(100)	GN(100)
Tradegroup Mechanic	AGPROP	6000		GT(85)	GT(90), GN(100)	GN(100)	GN(100)
[illegible] Gunner	AGRED	7212	90	PA(80)	GT(80), PA(80)	PA(90)	PA(90)
Ammunition Storage	AGSUP	2311	100	GT(90)	GT(90), AR(11)	GT(90)	GT(90)
Assault Amphibian Crewman	AGTRAC[i]	1833	90	PA(80)	PA(80)	PA(90)	PA(90)
Artillery Ballistic Meteorology	AGWAM[j]	0047	100	GT(90)	GT(90), PA(90)	PA(100)	PA(100)
Marine Artillery Scout Observer	AGWOCB	0861	90	PA(80)	GT(100), PA(90)	PA(90)	PA(100)
Aviation Support Equipment Technician (Electrical)	AMAE7	6000		GN(80), GT(85)	GN(100), GT(90)	GN(100)	GN(100)
Audio/TV Production Specialist	AMAGTV	4673		GT(90)	GT(90)	GT(110)	GT(110)
Basic Automotive Mechanic	AMAOMBC	3521	80	GT(90)	GT(90)	GT(90)	GT(100)

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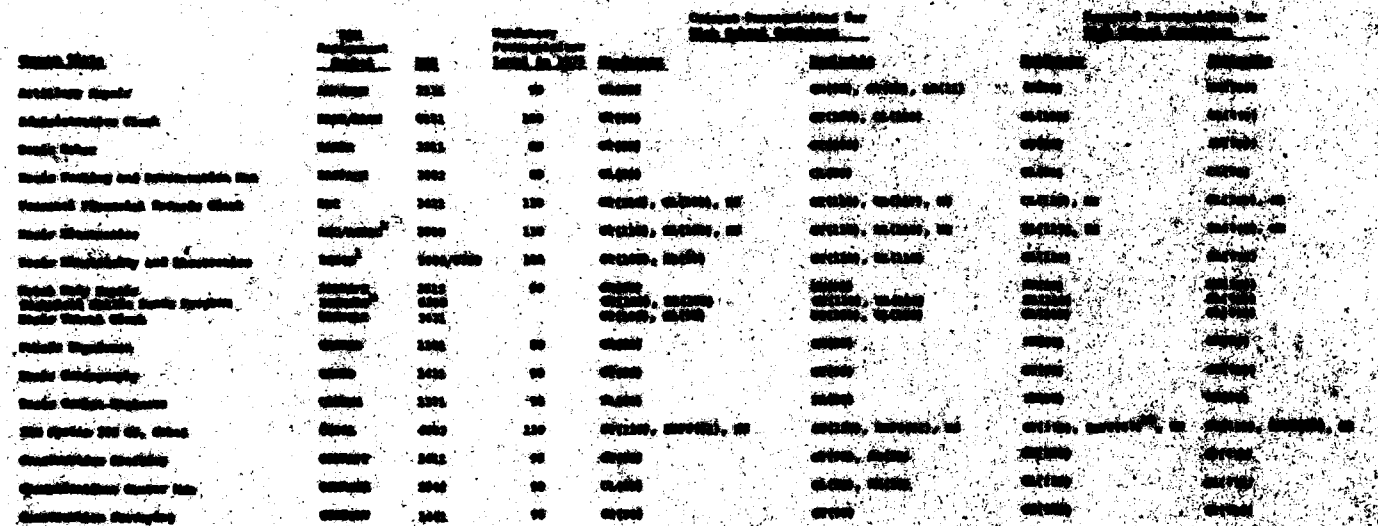

TABLE I (Cont'd)

Course Title	MOS Assignment Subject	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Cartographer Specialist	[illegible]	3031	90	[illegible]	[illegible]	[illegible]	[illegible]
Topographic Technician, C	[illegible]	3041	105	[illegible]	[illegible]	[illegible]	[illegible]
Topographic Technician, B	[illegible]	3051	110	[illegible]	[illegible]	[illegible]	[illegible]
Topographic Technician, T	[illegible]	3051		[illegible]	[illegible]	[illegible]	[illegible]
Defense Language Institute	[illegible]	3069	110	[illegible]	[illegible]	[illegible]	[illegible]
Radio Engineer Equipment Mechanic	[illegible]	1341	90	[illegible]	[illegible]	[illegible]	[illegible]
Engineering Equipment Operator	[illegible]	1345	90	[illegible]	[illegible]	[illegible]	[illegible]
Electronic Equipment Repairman	[illegible]	1345	110	[illegible]	[illegible]	[illegible]	[illegible]
Radio Electrician	[illegible]	1345	100	[illegible]	[illegible]	[illegible]	[illegible]
Radio Amphibious Educational Aid	[illegible]	0400	100	[illegible]	[illegible]	[illegible]	[illegible]
Financial Accounting Clerk	[illegible]	3401	100	[illegible]	[illegible]	[illegible]	[illegible]
Field Auxiliary Radar Crewman	[illegible]	0842	100	[illegible]	[illegible]	[illegible]	[illegible]
Field Auxiliary Fire Control	[illegible]	0844	100	[illegible]	[illegible]	[illegible]	[illegible]
Fire Control Instrument Repair	[illegible]	2171	100	[illegible]	[illegible]	[illegible]	[illegible]
Radio Post Service Man	[illegible]	2371	80	[illegible]	[illegible]	[illegible]	[illegible]
Radio Lithographic Processor	[illegible]	3532	80	[illegible]	[illegible]	[illegible]	[illegible]

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TABLE I (Cont'd)

Course Title	MOS Assignment (Enlist)	MOS	Mandatory Proficiency Level in 1975	Current Prerequisites for High School Graduates: Mandatory	Current Prerequisites for High School Graduates: Desirable	Proposed Prerequisites for High School Graduates: Mandatory	Proposed Prerequisites for High School Graduates: Desirable
Continuous Photogrammetric Specialist	[illegible]	4671	90	GT(100)	GT(100)	GT(110)	GT(120)
Basic Plumbing and Water Supply Tech	[illegible]	1121	90	MM(100)	GM(100), AR(110)	MM(100)	MM(120)
Postal Operations	[illegible]	0161	95	GT(100), CL(100)	GT(100), CL(100)	CL(100)	CL(100)
Quartermaster Equipment Repair	[illegible]	1172	90	MM(100)	GM(100)	MM(100)	MM(100)
Basic Refrigeration Mechanic	[illegible]	1161	100	GM(100)	GT(90), GM(90)	MM(100)	MM(100)
Shipfitter	[illegible]	2161	100	GM(90)	GM(90), AR(11)	MM(100)	MM(100)
Gun Duty	[illegible]	0300	90	CO(100)	CO(100)	CO(100)	CO(100)
Shore Fire Control Party	[illegible]	0651	90	FA(100)	FA(90), GT(100)	FA(100)	FA(100)
Still Photographic Specialist	[illegible]	4641	90	GT(100), CL(90), AR(11)	GT(100), CL(100), AR(11)	GT(100)	GT(110)
Subsistence Supply Man	[illegible]	3081	90	GT(100), CL(100)	GT(100), CL(100)	CL(100)	CL(100)
Boiler Supply Steam Control Man	[illegible][a]	3043	100	GM(110), CL(110), AR(11), ME	GT(110), CL(110), AR(11), ME	CL(110), ME	CL(110), ME
Administrative Clerk	S 0151	0151	100	GT(100)	GT(100)	CL(100)	CL(110)
Infantry Training	S 0300/0302300	0300	80	CO(100)	CO(100)	CO(100)	CO(100)
Logistics Operations Clerk	S 0441/0304413A	0441	90	CL(100)	CL(100), GT(90)	CL(100)	CL(110)
Field Artillery Subsystems	S 0811/0308113[a]	0811	80	FA(100)	FA(100)	FA(100)	FA(100)
Combat Engineer	S 1371/0313713	1371	80	GT(100)	GT(100)	GT(100)	GT(100)

TABLE I (Cont'd)

Course Title	MOS Assignment Symbol	MOS	Mandatory Prerequisites Level in 1979	Current Prerequisites for High School Graduates: Mandatory	Current Prerequisites for High School Graduates: Desirable	Proposed Prerequisites for High School Graduates: Mandatory	Proposed Prerequisites for High School Graduates: Desirable
Shore Party Specialist	S 1301/MS1301	1301	80	FA(80)	FA(80)	MM(80)	MM(90)
Bulk Fuel Specialist	S 1301/MS1301	1301	80	FA(80)	FA(80)	MM(80)	MM(90)
Antrac Crewman	S 1833/MS1833	1833	90	FA(80)	FA(80)	FA(90)	FA(90)
Field Wireman	S 2512/MS2512	2512	90	EL(80)	EL(90)	EL(90)	EL(90)
Field Radio Operator	S 2531/MS2531	2531	90	GT(80)	GT(80), EL(90), VE(10)	EL(90)	EL(100)
Warehouse Clerk	S 3051/MS3051	3051	90	CL(80)	CL(90)	CL(80)	CL(100)
Purchasing and Contracting Specialist	S 3081	3081	CM	CL(110), MM	CL(110), GT(100), MM	CL(110), MM	CL(110), MM
Freight Operations Clerk	S 3111	3111	80	CL(80)	CL(90)	CL(80)	CL(90)
Freight Transportation Clerk	S 3121	3121	80	CL(80)	CL(80)	CL(90)	CL(90)
Passenger Transportation Clerk	S 3141	3141	80	CL(80)	CL(90)	CL(90)	CL(90)
Baker	S 3311	3311	80	GT(90)	GT(100)	GT(90)	GT(100)
Cook	S 3371A[R]	3371	80	GT(90)	GT(100)	GT(90)	GT(100)
Heavy Vehicle Operator	S 3531A[V]	3531	80	MM(80)	MM(80)	MM(80)	MM(90)
Light Vehicle Operator	S 3535A[V]	3535	80	MM(80)	MM(80)	MM(80)	MM(90)
Marine Corps Exchange Man	S 4132	4132	90	CL(80), GT(80)	CL(90), GT(90)	CL(90)	CL(100)
Audiovisual Operations Specialist	S 4621	4621		CL(90)	CL(90)	CL(100)	CL(100)

TABLE I (Cont'd)

Course Title	MOS Assignment Initial	MOS	Mandatory Prerequisites Level in 1972	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Tank Crewman	[illegible][1]	1811	90	FA(80)	FA(80)	FA(90)	FA(90)
Armored Amphibian Engineman	[illegible]	2142	100	ST(80)	ST(90), AR(11)	ST(100)	ST(100)
Tracked Vehicle Repair, Artillery	[illegible]	2164	100	MM(80)	MM(90), AR(11)	MM(100)	MM(100)
Tracked Vehicle Repair, Tank	[illegible]	2165	100	MM(80)	MM (90),AR(11)	MM(100)	MM(100)
Infantry Training	[illegible][2]	0300	90	CO(80)	CO(80)	CO(90)	CO(90)
Infantry Training	[illegible][3]	0311	90	CO(80)	CO(80)	CO(90)	CO(90)

TABLE I (Cont'd)

[a]Prerequisites for non-high school graduates are 10 points higher.
[b]Also [illegible].
[c]Also [illegible].
[d]Also [illegible], [illegible].
[e]Also [illegible].
[f]Also [illegible].
[g]Also [illegible], [illegible].
[h]Also [illegible].
[i]Also [illegible].
[j]Also [illegible].
[k]Also [illegible], [illegible], [illegible].
[l]Also [illegible], [illegible].
[m]Also [illegible].
[n]Also [illegible].
[o]Also [illegible].
[p]Also [illegible].
[q]Also [illegible].
[r]Also [illegible].
[s]Also [illegible].
[t]Also [illegible].
[u]Also [illegible].
[v]Also [illegible], [illegible], [illegible].
[w]Also [illegible], [illegible].
[x]Also [illegible].
[y]Also [illegible].
[z]Also [illegible].
[aa]Only high school diploma graduates for assignments denoted by HS.
[bb]The Electronic Data Processing Test (EDPT) is a special non-ASVAB test.
[cc]The Army Language Aptitude Test (ALAT) is a special non-ASVAB test.

TABLE IX

[illegible] ARMY, 8/9/10 Composites

Course grouping	Symbol	Test content[a]
Mechanical	MM	[illegible]
Electrical	EL	[illegible]
Clerical	CL	[illegible]
General	GT	[illegible]
	AFQT	[illegible]

[a]Tests are defined in table 1 of the main text.

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CHAPTER 1

INTRODUCTION

BACKGROUND

The Armed Services Vocational Aptitude Battery (ASVAB) is the test currently used by the armed services to measure the mental aptitudes of prospective recruits. Scores on the ASVAB are used to determine eligibility for enlistment and to classify individuals with respect to the type of military jobs that best match their aptitudes. This report is concerned with the classification aspect of ASVAB.

The subject of this report is the validation of ASVAB forms 6 and 7 (ASVAB 6/7) for Marine Corps recruits. The term validation is used here to mean the establishment of a relationship between test scores on ASVAB 6/7 and subsequent performance in military training courses. The strength of the relationship will be measured by the size of the correlation coefficient between recruits' scores on ASVAB and their performance in training courses (validity). If such a relationship is found to exist, and if the relationship is a strong one, then the ASVAB may be viewed as a valid instrument for the selection and classification of recruits.

The study request and data collection plan for this analysis are given in appendix A. Initially the study was envisioned as beginning in 1977. Analysis was to follow 2 years of data collection and a report was to have been issued in late 1979. However, in early 1978 the study sponsor requested a revised study plan that called for reports based on analysis of the partially completed data set by September 1978. These reports [1, 2, and 3] were made available as requested. The full data collection was completed in 1979. This report represents an analysis of the full data set and draws on the earlier results [1, 2, and 3] as appropriate.

Accepted testing policy calls for the occasional replacement of enlistment tests with new forms of equal difficulty. The new forms usually cover similar content areas and differ from the previous forms only in an evolutionary sense. With a replacement policy of this kind, validity information from previous forms of the ASVAB serves as a useful estimate of the validity of replacement forms until data collection and analysis for the replacement forms are completed. ASVAB 6/7 was replaced by ASVAB 8/9/10 on 1 October 1980. We expect results on the validity of ASVAB 6/7 can be generalized for ASVAB 8/9/10 until the new forms can be directly validated.

In July 1980 the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) reported [4] that ASVAB 6/7, in use from January 1976 through September 1980, was miscalibrated and that this

miscalibration inflated the test scores of some enlistees during this period. A revised calibration of ASVAB 6/7 was made available [5]. The parts of this analysis that deal with absolute values of ASVAB scores (such as minimum prerequisites) were revised to reflect the corrected calibration of ASVAB 6/7. The corrected calibration ensures that a given score on ASVAB 6/7 represents the same ability level as that same score will on the new ASVAB 8/9/10. As a result of this revision the findings of this analysis with respect to minimum prerequisites on ASVAB 6/7 should be directly applicable to ASVAB 8/9/10.

STRUCTURE OF ASVAB 6/7

ASVAB 6/7 consists of 16 individual tests (see table 1) designed to measure aptitudes and interest in a variety of content areas. For use in classification, groups of the tests are combined into aptitude composites shown in table 2. The composites in table 2 are constructed from the tests in table 1 by using the formulas in table 3. See [6] for details on the construction of the composites. If the ASVAB is a valid predictor of success then recruits who, for example, make high scores on the Electronics composite will be expected to do well in electronics training. The composites used by other services will also be examined in this report and are described in appendix B.

TABLE 1

INDIVIDUAL ASVAB 6/7 TESTS

GI = General Information
NO = Numerical Operations
AD = Attention to Detail
WK = Word Knowledge
AR = Arithmetic Reasoning
SP = Spacial Perception
MK = Mathematics Knowledge
EI = Electronics Information
MC = Mechanical Comprehension
GS = General Science
SI = Shop Information
AI = Automotive Information
CC = Combat Scale
CA = Attentiveness Scale
CE = Electronics Scale
CM = Maintenance Scale

TABLE 2

MARINE CORPS ASVAB 6/7 COMPOSITES

CO = Combat
FA = Field Artillery
OF = Operators and Food Handlers
MM = Mechanical Maintenance
GM = General Maintenance
CL = Clerical
GT = General Technical
EL = Electronics
SC = Surveillance and Communications
ST = Skilled Technical
GCT[a] = General Classification Test

[a]When expressed in percentile form this composite is known as the Armed Forces Qualification Test (AFQT).

TABLE 3

FORMULAS FOR COMPUTING MARINE CORPS ASVAB 6/7 COMPOSITES

CO	= AR + SI + SP + AD + CC
FA	= AR + GI + MK + EI + CA
MM	= MK + SI + EI + AI + CM
GM	= AR + GS + MC + AI
CL	= AR + WK + AD + CA
GT	= AR + WK
EL	= AR + GS + MK + EI
SC	= AR + WK + MC + SP
ST	= AR + MK + GS
OF	= GI + AI + CA
GCT[a]	= AR + WK + SP

[a]When expressed in percentile form this composite is known as the Armed Forces Qualification Test (AFQT).

OBJECTIVES

The objectives of this analysis as set forth in the study request (appendix A) are:

a. To determine the best existing aptitude composite for predicting service school completion. This evalution

includes composites currently used by other services as well as those used by the Marine Corps

b. To determine the best combination of subtests for predicting service school completion

c. To determine the relationship of civilian educational level and aptitude composites on service school completion

d. To determine service school prerequisites that will ensure high rates of service school completion without unduly restricting the supply of qualified persons.

METHOLODOGY

The primary methodology used to address objective (a) is an analysis of correlations between measures of performance in service schools and ASVAB 6/7 composites. The correlation analysis will be supplemented by regression analysis, factor analysis, and graphical analysis in addressing objectives (b), (c), and (d).

DATA

The primary data sample used in this report consists of aptitude test scores and school performance data on 26,039 Marine Corps recruits entering training during 1977 and 1978.

All aptitude test scores are from ASVAB 6/7 tests that were administered within the first few days after arrival at recruit depots. These scores were available for all recruits in the 1977-1978 data set. ASVAB scores from recruit depot testing were used, rather than those from tests taken at the Armed Forces Examining and Entrance Stations (AFEES), to minimize test compromise effects.

Data was collected for 46 courses. Table 4 lists the complete course titles and sample sizes.

Initially we considered final course grade (FCG), time to complete the course (TIME), and pass/fail (P/F) as measures of school performance. Closer inspection revealed that only the FCG criterion

TABLE 4

COURSES EXAMINED IN THIS ANALYSIS

Course	Size of sample: Pass/fail (P/F)	Size of sample: Final course grade (FCG)	Size of sample: Time to complete (TIME)
Basic supply stock clerk	1,243	997	
Personal financial records clerk	380	347	
Basic automotive mechanic	1,316	1,264	
Advanced automotive mechanic	685	610	
Basic baker	168	158	
Basic food service	604	578	
Basic combat engineer	941	927	
Basic electrician	225	224	
Electrical equipment repairman	218	213	
Basic engineer equipment mechanic	700	688	
Administrative clerk	1,420	1,325	
Personnel clerk	207	176	
Unit diary clerk	166	148	
Sea duty indoctrination	1,212	537	
Basic electronics	1,132	992	
Radio fundamentals	169	157	
Field radio operator	1,260	1,217	
Communications center man	722	679	
Air control electronic operator	89	73	
Infantry training	4,199	4,117	
Tracked vehicle repair	252	233	
Basic helicopter	820	789	
Aviation structural mechanic (safety equipment)	125	123	
Aviation structural mechanic (hydraulics)	565	551	
Aviation structural mechanic (structures)	627	592	
Aviation ordnance	292	283	
Aviation crash crew	296	294	
Avionics repairman	301	290	
Air controlman	91	76	
Air control maintenance	95		
Aircraft launch and recovery	95	94	
Air crew survival equipment	175		172
Marine aviation operations (clerical)	250	247	
Aviation maintenance administration	234	214	
Marine aviation supply (mechanical)	534	494	
Aerographers mate	128	45	
Small arms repair	324	323	
Tank crewman	438		
Field artillery fire control	485	96	
Ammunition storage	313	306	
Corrections specialist	223		
Military police	777		
Basic cannoneer	204	163	
Basic electricity & electronics	968		968
Aviation machinists mate	233		233
Avionics technician	138		138
Total	26,039		

gave satisfactory results.* For this reason and to increase the statistical reliability of the results, we conducted the validity analysis only on the 33 FCG schools with 100 or more cases. The data on the remaining 13 schools was only used as an aid in setting minimum composite levels. Individual recruits with FCG of 60 or less were removed from the validity analysis because these grades appeared to be arbitrarily determined; hence, their inclusion would bias the results.

Course performance data for the first 43 courses in table 4 was collected directly from the schools on optically scannable sheets. Course data for the remaining three courses is from the Navy Integrated Training Resource and Administration System (NITRAS). All aptitude test data is from the Marine Corps Recruit Accession Management System (RAMS).

An additional source of data was FY 1980 course failure rates (as distinguished from data on individual recruits) for 86 out of the 94 formal training courses used for Marine Corps recruits. This data supplements our 1977-1978 data by providing a more recent picture of school performance.

ORGANIZATION OF THE REPORT

The validity of the individual ASVAB 6/7 tests is addressed in chapter 2, and that of the composites in chapter 3. In chapter 4 we discuss the applicability of ASVAB 6/7 validity results for the new ASVAB 8/9/10. In chapter 5 we examine the relationship between failure rates in service courses and prerequiste levels. In chapter 6 we develop an experimental set of improved composites for ASVAB 8/9/10.

* ASVAB scores generally exhibited lower correlations with TIME and P/F then they did with FCG. The TIME variable appeared to have been administratively predetermined in some courses. The use of the P/F variable would have necessitated corrections for restriction of range on a dichotomous variable. These corrections, which will be discussed later, are not satisfactory on dichotomous variables. For these reasons we restricted the validity part of our analyses to those courses with a FCG criterion.

CHAPTER 2

VALIDITY OF INDIVIDUAL ASVAB 6/7 TESTS

In this section we examine the validity of each of the 16 tests that make up ASVAB 6/7. These tests are defined in table 1. The validity of composites will be examined in a later section. Validity is defined as the correlation between a performance criterion (in this case FCG) and scores on ASVAB 6/7. Tests that exhibit very low validity do not contribute to the predictive power of the ASVAB and should be eliminated or replaced.

VALIDITY COEFFICIENTS

Validity coefficients were calculated for each of the 16 ASVAB 6/7 tests in each of the 33 courses examined. The coefficients, uncorrected for range restriction, are tabulated in appendix C. These coefficients must be corrected for range restriction before they are interpreted. This correction is discussed in the following paragraphs.

The desired output from this analysis is validity data that is appropriate to use with the entire pool of recruits available for assignment. Ideally the results would indicate which ASVAB test or tests best predicts performance in each school and, hence, which one to use in assigning recruits to each school. Operationally, the data we collect represents school performance on recruits that have already attended the service school. They were, of course, selected for assignment to that school on the basis of some ASVAB test. As a result of that selection the scores of our sample of recruits will, for each course, be restricted to high values in whatever ASVAB test was considered important as a predictor for that course. This "restriction of range" will lower the observed correlation between this ASVAB test and school performance with respect to what it would have been had we been able to observe the performance of the entire recruit population. This lowering of the correlation will, in general, affect the relative size of validity coefficients for the various ASVAB tests. To ascertain the true validities of each ASVAB test we must correct for the restriction of range.

We make this correction using a standard multivariable correction program, developed by [7], that uses the methodology of Burt [8]. The details of the correction are given in appendix D. The corrected validity coefficients are shown for each course in table 5. From table 5 we see, for example, that the validity coefficient for the ASVAB 6/7 MK test is 0.56 for the Supply Stock Clerk course. The MK coefficient is the highest of any test for this course, which indicates that the MK test is the best predictor of success in training as a supply stock clerk.

TABLE 5

CORRECTED VALIDITY COEFFICIENTS[a] FOR INDIVIDUAL ASVAB 6/7 TESTS

Courses	Tests															
	GI	NO	AD	WK	AR	SP	MK	EI	MC	GS	SI	AI	CM	CA	CE	CC
Basic supply stock clerk	36	35	13	43	50	26	56	39	36	45	26	26	00	20	17	18
Personal financial records clerk	33	46	24	42	61	36	62	36	40	47	28	31	11	27	19	30
Basic auto mechanic	47	30	12	43	50	33	48	60	57	53	56	61	30	05	17	31
Advanced automotive mechanic	52	32	12	46	55	38	51	58	63	59	55	59	28	09	21	32
Basic baker	37	40	19	37	52	25	55	47	45	48	34	36	10	10	14	18
Basic food service	34	33	13	34	46	26	45	41	39	47	36	30	02	11	08	28
Basic combat engineer	49	34	11	45	55	39	53	54	57	55	51	48	14	06	14	31
Basic electrician	29	25	04	40	37	14	41	38	44	38	37	39	20	09	25	25
Electrical equipment repairman	39	27	-01	32	30	21	38	30	30	26	25	24	05	07	20	21
Basic engineer equipment mechanic	46	33	15	39	45	34	45	51	53	48	49	53	30	08	22	31
Administrative clerk	34	42	23	47	50	28	54	41	38	49	26	24	-02	23	14	22
Personnel clerk	31	46	18	45	52	26	58	37	33	39	21	21	14	31	29	23
Unit diary clerk	28	26	12	50	44	27	59	33	33	45	18	15	-11	28	20	17
Sea duty indoctrination	39	38	17	46	38	18	44	37	35	46	34	26	04	18	16	23
Basic electronics	38	42	23	42	54	35	60	50	49	53	31	34	11	17	34	21
Radio fundamentals	23	32	08	29	34	26	38	34	28	40	32	30	10	00	14	17
Field radio operator	35	31	15	42	45	27	48	42	41	44	31	33	09	11	18	20
Communications center man	41	47	16	49	52	27	54	33	37	45	21	24	-01	22	21	15
Infantry training	26	22	12	25	25	21	29	26	28	30	23	21	07	09	11	19
Tracked vehicle repair	46	35	16	56	56	36	53	48	53	60	37	42	05	09	19	21
Basic helicopter	47	30	08	45	47	28	50	50	51	50	45	48	16	02	17	25
Aviation structural mechanic (safety equipment)	38	29	22	45	47	32	50	49	46	40	32	34	28	08	24	35
Aviation structural mechanic (hydraulics)	48	32	13	50	52	36	51	53	58	56	52	48	21	02	16	33
Aviation structural mechanic (structures)	43	38	23	47	45	32	53	44	49	55	42	39	13	12	17	25
Aviation ordnance	46	30	10	43	48	33	53	46	49	49	38	38	10	04	16	19
Aviation crash crew	37	27	10	31	41	23	37	40	39	32	36	35	19	02	10	29
Avionics repairman	46	41	16	52	57	32	53	57	57	56	40	44	16	10	25	29
Aviation operations (clerical)	23	36	25	30	43	37	46	28	33	32	19	15	-06	12	08	16
Aviation maintenance administration	27	33	13	41	52	31	56	40	39	44	28	24	-03	11	20	10
Aviation supply (mechanical)	42	44	28	46	53	31	58	41	39	47	27	28	04	19	20	18
Small arms repair	25	24	22	26	38	43	36	35	38	29	36	34	17	03	09	21
Ammunition storage	52	33	16	50	48	32	51	48	43	55	44	40	12	15	23	26
Basic cannoneer	29	33	16	39	42	31	49	31	39	47	28	28	10	16	17	27

[a]Multiplied by 100.

DISCUSSION

In interpreting the coefficients in table 5 it is well to bear in mind that they contain statistical uncertainties ranging from 0.01 to 0.07. These are a function of the number of recruits in each course (appendix E). The restriction of range, described earlier, introduces additional distortion into the correlation coefficients. Some, but not all, of this error is removed during the range correction process described in appendix D. We estimate (see appendix D) that the uncorrectable uncertainties due to restriction of range vary from 0.00 to 0.11. These uncertainties, which are inherent in analysis of this type, indicate that we should strive for a general, rather than a highly specific, interpretation of the data. They also indicate that a few anomalous results should not be surprising, particularly in courses with small numbers of recruits.

To reduce the complexity of the interpretation of table 5 we carried out stepwise regression analysis,* using success in the course (FCG) as the dependent variable and the test data corrected for restriction of range as the independent variables. The results are summarized in table 6, showing the best combination of ASVAB tests for each course. The order of presentation of the best tests in table 6 is the order in which they entered the stepwise regression. The multiple correlation coefficient at each step in the regression is also shown. For example, in the Supply Stock Clerk Course the MK test was most important and correlated 0.56 with success in the course. The second test to enter the regression was WK. It, in combination with MK, produced a correlation with success in the course of 0.59. The third test to enter the regression is AR, which raises the multiple correlation only 0.01 to a total of 0.60. Additional tests add very little to the multiple correlation. In general, the data of table 6 shows that success in training courses (as measured by the multiple correlation coefficient) can be predicted reasonably well by a set of three ASVAB tests. Further, we see that in general, most of the predictive power is manifest in the first test of the three to enter the stepwise regression. The addition of the two additional tests adds only a small increment to the prediction.

In table 7 we summarize the most important test (first one entered in stepwise regression) and the three most important tests (first three entered in stepwise regression) for each course. The tests are grouped

*The F-values for the regressions were uniformly high. The values of the constant terms were reasonable and all variables shown were significant at the 0.05 level. All variables shown entered with positive signs, and the R^2 values generally were in the 0.4 to 0.5 range.

TABLE 6

COMBINATIONS OF CORRECTED VALIDITY COEFFICIENTS FOR INDIVIDUAL ASVAB 6/7 TESTS

Course	Best combination[a] of tests	Multiple correlation[b] for indicated number of tests				
		1	2	3	4	5
Basic supply stock clerk	MK, WK, AR, GS, CA	56	59	60	60	61
Personal financial records clerk	MK, AR, CA, CC, NO	62	67	68	69	69
Basic automotive mechanic	AI, MK, EI, SI, AR	61	68	71	72	72
Advanced automotive mechanic	MC, AI, AR, GS, GI	63	69	73	74	75
Basic baker	MK, EI, AR	55	60	62	62	62
Basic food service	GS, AR, MK, SI, CC	47	53	34	55	56
Basic combat engineer	MC, AR, EI, SI, MK	57	64	67	68	69
Basic electrician	MC, WK, AI, MK, CE	44	49	51	54	55
Electrical equipment repairman	GI, MK, CE	39	46	47	47	47
Basic engineer equipment mechanic	MC, AI, MK, GI, CM	53	60	64	64	65
Administrative clerk	MK, WK, NO, GS, CA	54	59	60	62	62
Personnel clerk	MK, NO, WK, CA, CM	58	61	63	65	66
Unit diary clerk	MK, WK, CA	59	64	66	66	66
Sea duty indoctrination	WK, NO, GS, MK, SI	46	52	55	56	57
Basic electronics	MK, EI, CE, GS, NO	60	65	66	68	69
Radio fundamentals	GS, NO, SI	40	45	47	47	47
Field radio operator	MK, EI, WK, AR, AI	48	53	55	55	56
Communications center man	MK, WK, NO, AR, GI	54	60	63	64	64
Infantry training	GS, MK, GI, SP, NO	30	33	35	35	36
Tracked vehicle repair	GS, AR, WK, MC, MK	60	67	68	70	70
Basic helicopter	MC, MK, AI, GI, WK	51	58	63	64	64
Aviation structural mechanic (safety equipment)	MK, EI, CM, WK, AD	50	58	61	63	64
Aviation structural mechanic (hydraulics)	MC, GS, AR, SI, MK	58	64	66	68	69
Aviation structural mechanic (structures)	GS, MK, SI, AD, WK	55	61	63	64	65
Aviation ordnance	MK, GI, MC, GS	53	59	62	62	62
Aviation crash crew	AR, EI, CC, GI	41	48	49	50	50
Avionics repairman	AR, EI, MC, WK, NO	57	67	69	70	71
Aviation operations (clerical)	MK, SP, NO, AR, AD	46	51	53	53	54
Aviation maintenance administration	MK, AR, GS	56	59	60	60	60
Aviation supply (mechanical)	MK, WK, NO, GI, AD	58	61	63	64	65
Small arms repair	SP, AR, SI, AD, AI	43	49	51	53	54
Ammunition storage	GS, GI, MK, SI, WK	55	61	64	65	66
Basic cannoneer	MK, GS	49	55	55	55	55
Mean		52	58	60	61	61

[a] In order entered into stepwise regression.

[b] Multiplied by 100. Some regressions terminated before five tests entered. In these cases the multiple correlation from the terminal step was assumed to hold for all remaining steps.

TABLE 7

RELATIVE IMPORTANCE[a] OF INDIVIDUAL ASVAB 6/7 TESTS

Group	Test	Number of courses for which the indicated test was: The most important		One of the 3 most important	
Math	MK	15	17	23	42
	AR	2		12	
	NO	0		7	
Verbal	WK	1	8	10	24
	GS	6		10	
	GI	1		4	
Shop	MC	6	7	8	24
	EI	0		8	
	SI	0		3	
	AI	1		5	
Attitudinal	CE	0	0	2	6
	CA	0		2	
	CM	0		1	
	CC	0		1	
Miscellaneous	SP	1	1	2	2
	AD	0		0	

[a]From stepwise linear regression.

in broad content areas.* We see that the MK test is by far the most important test in the battery. Tests from the math, verbal, and shop content areas are seen to be important both singly and in groups of three.

Tests in the attitudinal and miscellaneous content groups are seen to only be important for a few courses. The tests SI, SP, AD, GI, CE, CC, CM, and CA do not appear to be critical parts of the ASVAB.

The remaining parts of ASVAB 6/7 appear to be useful in predicting school performance and should be retained in the battery.**

The validity of aptitude composites constructed from individual ASVAB tests will be examined in chapter 3.

* The test grouping was determined by a factor analysis of the test battery. This analysis will be discussed in a later section.
** Based on preliminary results from this analysis, and from that of other service personnel research groups, it was decided to delete GI, SP, CA, CC, CE, CM, and AD from the new ASVAB 8/9/10, which became operational 1 October 1980. The AI and SI tests were replaced in ASVAB 8/9/10 by the AS test. The AS test contains mostly automotive questions (like AI) and only a few shop questions (like SI).

CHAPTER 3

VALIDITY OF ASVAB 6/7 COMPOSITES

BACKGROUND

The placement of individual recruits in specific service schools is determined, in part, by the recruits' scores on various ASVAB aptitude composites. In this chapter we examine the validity of each composite (see table 3) used by the Marine Corps. For purposes of comparison we also examined the validities of composites used by the Army, Navy, and Air Force. These composites are formed by combinations of individual ASVAB tests and are defined in appendix B.

The "differential" nature of the ASVAB composites will be a factor in our examination of validities. By differential we mean that the composites measure specific aptitudes that are predictors of success in specific training programs. For example, if a recruit scored very high in mechanical aptitude and low in other areas he would be assigned to a training program leading to a mechanical job. To the extent that different individuals do have different aptitudes and to the extent that the ASVAB can reliably measure these aptitudes, differential composites expand* the existing manpower pool.

We have considered two possible approaches to analyzing the validity data. One of these approaches, which we call "course specific," involves using validity data to pick the absolutely "best" composite (largest validity coefficient) for each course. The other approach, which we call "global," uses a priori judgment to group courses with apparently similar content. A composite is then determined that works resonably well for the group as a whole and the results are generalized to all courses in the group as well as any courses that may later be added to the group. In our opinion the global approach is the most satisfactory. The reasons for this conclusion will be discussed later.

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* This expansion is illustrated by the following example. Let us assume that the services have determined that only recruits of above average aptitude will be suitable for a group of courses in electrical, mechanical, and clerical areas. If we assigned recruits to all these courses based on the same composite (a "general" composite) we might find that only 50 percent of all recruits would meet the assignment standards. If however, we have separate composites for electrical, mechanical, and clerical courses we might find that 70 percent of all recruits would be above average in at least <u>one</u> aptitude area and, hence, qualified for a course. In this example the supply of qualified recruits would have been expanded by 20 percentage points.

VALIDITY COEFFICIENTS

Validity coefficients for each composite were computed for each course and are tabulated (uncorrected for restriction of range) in appendix C. The coefficients were corrected for range restriction using the methodology described in appendix D and are tabulated by course content area in table 8. For example, the correlation between success in auto mechanics training (final course grade) and the ASVAB 6/7 GM composite was 0.64. The approximate standard error in the correlation coefficient is 0.02. The courses are grouped into six aptitude areas based on a priori judgment. The mean validity for each composite in each aptitude area is shown. The validities of the composite we consider to be most appropriate for each grouping are outlined in the table. For example, we consider the ASVAB 6/7 GM composite to be most appropriate for use in courses in the mechanical grouping; the EL for those in the electrical grouping; the CL for those in the clerical grouping; the FA for those in the field artillery grouping; CO for those in the combat grouping; and GT for all other courses (i.e., the general grouping). That is our conclusion--now let us turn to the rationale.

SELECTION OF THE BEST COMPOSITE

Why were the composites chosen as outlined in table 8? First, let us examine the question of whether the global approach or the course specific approach is more appropriate for selecting the best composite for each course.

The coefficients tabulated in table 8 are only approximately correct. They are affected by statisitical uncertainties, which are a function of sample size, and by uncertainties resulting from inaccuracies caused by range restriction that can be only partially corrected by the range correction procedure. The statistical uncertainties can be calculated and are shown in table 8. The uncertainties due to range restriction that cannot be corrected are estimated in appendix D to range from 0.00 to 0.11. The combined effect of these sources of error leads to validity coefficients that are somewhat unreliable--even when based on large samples of data.

The uncertainty in the validity coefficients is compounded by the high intercorrelations among the composites themselves (see table 9). For example, the FA and ST composites correlate 0.97 with the EL composite. This implies that to a very good approximation, these three composites measure the same aptitude and are not really different.

The uncertainty in the validity coefficients and the high intercorrelations between composites produce a situation in which the simple assumption, that the best composite is the one with the largest validity coefficient, is not valid. If one applies the course specific approach to this situation one validity analysis will find that a certain composite is the "best" for a particular course. If a second validity

TABLE 8

CORRECTED ASVAB 6/7 VALIDITY COEFFICIENTS[a,b]

Group/course	Composite CO	FA	EL	OF	GM	MM	CL	ST	GT	SC	GCT	Standard[c] error in coefficient
Mechanical												
Basic automotive mechanic	55	59	60	57	64	65	44	55	50	56	51	02
Advanced automotive mechanic	58	60	61	59	66	62	47	57	52	59	55	03
Tracked vehicle repairman	50	56	61	46	59	46	55	64	63	63	75	05
Basic helicopter	44	52	53	47	54	52	40	49	48	51	48	03
Aviation structural mechanic (safety equipment)	50	52	51	37	46	50	47	47	50	51	51	06
Aviation structural mechanic (hydraulics)	56	55	58	48	60	56	47	54	52	58	55	03
Aviation structural mechanic (structures)	49	52	53	44	52	47	49	52	46	52	49	03
Basic engineer equipment mechanic	54	58	60	54	62	56	46	59	49	60	54	02
Small arms repair	49	41	42	31	41	42	36	39	33	45	43	05
Basic combat engineer	57	61	63	52	66	58	46	61	54	61	57	02
Aviation crash crew	43	46	46	38	44	44	34	42	39	42	41	05
Mean	51	54	55	47	56	53	45	53	49	54	53	
Electrical												
Basic electronics	50	61	61	42	55	49	50	60	58	56	56	02
Radio fundamentals	35	39	44	26	37	36	29	42	43	37	38	07
Avionics repair	52	60	62	47	61	54	52	54	62	60	59	04
Field radio operator	43	49	49	39	49	44	44	48	45	47	46	02
Basic electrician	35	40	40	40	44	45	33	36	39	40	36	06
Electrical equipment repairman	29	38	33	32	32	32	26	30	36	37	35	06
Mean	41	48	48	38	46	43	39	45	47	46	45	
Clerical												
Administrative clerk	47	55	55	39	49	41	53	54	53	50	51	02
Personnel clerk	44	56	52	39	44	41	53	53	52	49	51	05
Unit diary clerk	35	51	47	32	39	32	49	50	56	49	52	06
Basic supply stock clerk	40	54	52	39	45	40	46	53	51	47	49	03
Personal financial records clerk	54	58	56	43	52	47	56	58	58	53	54	04
Aviation operations (clerical)	44	41	42	23	36	27	41	43	36	43	47	05
Aviation maintenance administration	40	49	52	30	45	37	44	52	50	49	50	06
Aviation supply (mechanical)	49	58	57	43	51	44	55	56	51	52	53	03
Communications center man	40	54	52	40	47	35	51	55	54	51	52	03
Mean	44	52	52	36	45	38	50	53	51	49	51	

TABLE 8 (Cont'd)

Group/course	Composite CO	FA	EL	OF	GM	MM	CL	ST	GT	SC	GCT	Standard[c] error in coefficient
Field artillery												
Basic cannoneer	46	[46]	49	36	53	39	43	52	44	52	48	06
Mean	46	[46]	49	36	53	39	43	52	44	52	48	
Combat												
Infantry training	[31]	34	34	28	33	29	28	33	28	32	30	02
Sea duty indoctrination	40	48	47	39	42	38	46	46	43	42	42	04
Mean	[36]	41	41	34	38	34	37	40	36	37	36	
General												
Ammunition storage	52	57	57	51	55	51	50	53	[51]	53	52	04
Aviation ordnance	44	52	52	42	50	48	41	51	47	49	49	05
Basic baker	46	55	58	43	54	51	43	53	43	45	43	06
Basic food service	47	52	56	39	52	44	40	54	43	45	43	04
Mean	47	54	56	44	53	49	44	53	[46]	48	47	

[a] Coefficients were multiplied by 100 to eliminate decimal points.

[b] Coefficients of preferred composites for each grouping are outlined.

[c] Statistical error only--does not include error due to range restriction remaining after correction for range restriction.

TABLE 9

CORRELATIONS[a] OF COMPOSITES[b] FROM ASVAB 6/7

	CO	FA	EL	OF	GM	MM	CL	ST	GT	SC	GCT
CO	--	82	82	72	84	80	84	80	80	88	87
FA	82	--	97	85	90	85	90	94	91	91	91
EL	82	97	--	78	93	87	86	97	91	92	91
OF	72	85	78	--	85	84	77	72	76	77	75
GM	84	90	93	85	--	90	82	91	89	93	89
MM	80	85	87	84	90	--	71	78	77	82	78
CL	84	90	86	77	82	71	--	87	93	90	91
ST	80	94	97	72	91	78	87	--	91	90	90
GT	80	91	91	76	89	77	93	91	--	95	97
SC	88	91	92	77	93	82	90	90	95	--	99
GCT	87	91	91	76	89	78	91	90	97	99	--

[a]From a stratified sample of 2,025 applicants from all services tested at AFEES.
[b]Marine Corps composites only.

analysis is conducted on the same course a different "best" composite may be deduced. This instability of validity results using the course specific approach is illustrated in table 10. This table compares the composite with the highest validity from approximately the first half of our data sample [1] with that from the complete data sample. Only in 41 percent of the courses would the course specific method, picking the composite with the largest coefficient, have given the same result for the half sample and the complete sample. Instability of results from the course specific approach would result in the frequent and capricious changing of course prerequisites without any real improvement in selection. In our opinion this would be an unsatisfactory outcome and for this reason we reject the course specific approach in favor of the global approach.*

Mechanical Grouping

The global approach to composite selection minimizes the effect of uncertainty in validity coefficients by averaging them over a number of courses. For example, in table 8 we see that the mean validity coefficient for GM is 0.56. This is the highest mean validity of any composite and indicates that GM is a reasonable choice of composite for selection into mechanical training areas. We note that even for those mechanical courses for which GM does not have the highest validity, there are no cases in which an alternative composite is demonstrably better when uncertainties in coefficients are considered. The content areas contained in GM (see table 3) reflect significant mechanical aptitude. Hence, from the point of view of "face validity"** the choice of GM is also appropriate. A comparison of the validities of GM and MM (both of which have been used in the past as selectors for mechanical courses) does not indicate any compelling reason to use MM for some mechanical courses and GM for others. Hence, we chose GM for all mechanical courses.

It is readily apparent that there are a number of other composites with validities almost as high as GM. This is, however, more a reflection on the number of highly correlated composites than on the appropriateness of the choice of GM as a selector composite for mechanical courses.

* An application of the global approach to the first half of the data produced stable results; i.e., results that were very similar to those shown in table 8 for the full data sample.

** Face validity refers to validity that may be assumed because the test content is clearly related to aptitude for a particular course. For example, the General Maintenance (GM) composite contains the Mechanical Comprehension (MC) test. Clearly, mechanical comprehension should be expected to be relevant to success in maintenance courses; hence, the GM composite may be said to have face validity for these courses.

TABLE 10

STABILITY OF COMPOSITE SELECTION BASED ON HIGHEST VALIDITY

Area/course	Composite[a] with highest validity: First half of sample[b]	Composite[a] with highest validity: Complete sample
Mechanical		
Basic automotive mechanic	GM	MM
Advanced automotive mechanic	GM	GM
Tracked vehicle repairman	GT	GCT
Basic helicopter	GM	GM
Aviation structural mechanic (safety equipment)	-[c]	FA
Aviation structural mechanic (hydraulics)	CO	GM
Aviation structural mechanic (structures)	ST	EL
Basic engineer equipment mechanic	GM	GM
Small arms repair	CO	CO
Basic combat engineer	GM	GM
Aviation crash crew	MM	EL
Electrical		
Basic electronics	GT	EL
Radio fundamentals	-[c]	EL
Avionics repairman	EL	GT
Field radio operator	EL	EL
Basic electrician	GM	MM
Electrical equipment repairman	SC	FA
Clerical		
Administrative clerk	GT	EL
Personnel clerk	FA	FA
Unit diary clerk	ST	GT
Basic supply stock clerk	FA	FA
Personal financial records clerk	GT	ST
Aviation operations (clerical)	CO	GCT
Aviation maintenance administration	GT	EL
Aviation supply (mechanical)	EL	FA
Communications center man	ST	ST
Field artillery		
Basic cannoneer	-[c]	GM

TABLE 10 (Cont'd)

Area/Course	Composite[a] with highest validity: First half of sample[b]	Composite[a] with highest validity: Complete sample
Combat		
Infantry training	EL	EL
Sea duty indoctrination	-[c]	FA
General		
Ammunition storage	EL	FA
Aviation ordnance	GT	EL
Basic baker	EL	EL
Basic food service	EL	EL

[a]Marine Corps composites only.
[b]Taken from [1].
[c]Data not available.

Electrical Grouping

The mean validity of the EL composite for the electrical grouping is 0.48 (table 8). Both the EL and FA composites have equally high validities for this group; but this is not surprising given their high intercorrelations (table 9). Clearly, either FA or EL could be used for this group, but because EL was designed specifically for such courses it seems the most reasonable choice. Reference to table 3 shows that the EL composite has face validity as a selector for electrical (and electronics) courses.

The EL composite is a highly effective predictor of school performance. It may even be said to be "too good" in that it has the highest or near highest mean validity coefficient for every grouping in table 8. However, its high level math content (MK) should not be wasted on job areas for which a lower level math ability would suffice. For this reason its use should be restricted to the electrical grouping

Clerical Grouping

From table 8 we see that the CL composite with mean validity of 0.50 is a reasonable choice as a selector composite for the clerical grouping. Although the mean validity for CL is not quite as high as that of EL, FA, and ST, it is satisfactory and its choice both preserves and illustrates the differential character of the battery. Reference to the electrical grouping of table 8 shows that EL (validity of 0.48) is a significantly better predictor for electrical courses than CL (validity of 0.39). For clerical courses CL (validity of 0.50) is almost as good as EL (validity of 0.52). By selecting recruits for electrical courses on EL and clerical courses on CL we will, in general, get better overall school performance* from the same manpower pool than had we selected recruits for both groupings on EL alone.

Field Artillery

Only one course was available for study in the field artillery area. The composite designed for field artillery (FA) is a reasonable selector because its validity (0.46), although not the highest, is within the expected range of uncertainty (approximately one standard error).

*The number of recruits with high EL (or CL) scores is limited If we assigned recruits to both electrical and clerical schools on the basis of EL scores we would probably deplete the supply of recruits with high EL scores. This would result in either empty school seats or the assignment of below average recruits to some electrical or clerical courses, thereby lowering overall performance.

There is some question about a real need for a separate field artillery composite. This question should be explored further in subsequent validity analyses.

Combat

All composites have rather low validity for the combat area. This result may indicate that the criterion variable is poorly defined. In any event, the mean validity (0.36) of the combat composite (CO) is not much worse than that of the other composites. We recommend its continued use pending further validity analysis and an examination of other criterion variables such as job performance measures.

General

Courses in the general area are by definition those that do not belong to any well defined group. An examination of table 8 discloses that the highest mean validities are associated with GM, EL, and the EL surrogates, i.e., FA and ST. To choose any of these as the selector for this grouping would reduce their effectiveness in their specialty areas. We recommend the use of GT (validity 0.46) for this area. The recommendation is primarily based on face validity considerations, i.e., the course content seems to require the ability to read and that is measured well by GT.

Comparison of Current and Proposed Composites

A comparison of currently used aptitude composites and those proposed for ASVAB 6/7 from this analysis is given in table 11. It is seen that the changes proposed are not radical. The proposal is really simply to use the composites that are designed for a content area as selectors in all courses that seem to belong in that content area unless very strong and reproducible evidence can be cited to show them to be unsatisfactory.

These validity results can be generalized to courses other than those listed by simply placing the course in the appropriate grouping and using the aptitude composite for that grouping.

MULTIPLE COMPOSITES

Some courses currently use multiple commposites as prerequisites (for example, GT and EL). Apparently, the idea is that if one composite is good then two should be even better. The facts are that two are, of course, better--but only a little better, and the cost of the additional composite is very high.

We examined the effect of multiple composites on validity using stepwise regression analysis. Table 12 summarizes the validity coefficients obtained from the "best" single composite and the best two

TABLE 11

COMPARISON OF CURRENT AND PROPOSED ASVAB 6/7 APTITUDE COMPOSITES

Area/course	ASVAB 6/7 aptitude composite	
	Current[a]	Proposed
Mechanical		
Basic automotive mechanic	MM	GM
Advanced automotive mechanic	MM	GM
Tracked vehicle repairman	MM	GM
Basic helicopter	GM	GM
Aviation structural mechanic (safety equipment)	GM	GM
Aviation structural mechanic (hydraulics)	GM	GM
Aviation structural mechanic (structures)	GM	GM
Basic engineer equipment mechanic	MM	GM
Small arms repair	GM	GM
Combat engineer	GT	GM
Aviation crash crew	GM	GM
Electrical		
Basic electronics	GT	EL
Radio fundamentals	GT	EL
Avionics repairman	GT	EL
Field radio operator	EL	EL
Basic electrician	EL	EL
Electrical equipment repairman	EL	EL
Clerical		
Administrative clerk	CL	CL
Personnel clerk	CL	CL
Unit diary clerk	CL	CL
Basic supply stock clerk	CL	CL
Personal financial records clerk	CL	CL
Aviation operations (clerical)	CL	CL
Aviation maintenance administration	CL	CL
Aviation supply (mechanical)	CL	CL
Communications center man	CL	CL
Field artillery		
Basic cannoneer	FA	FA

TABLE 11 (Cont'd)

Area/course	ASVAB 6/7 aptitude composite	
	Current[a]	Proposed
Combat		
Infantry training	CO	CO
Sea duty indoctrination	CO	CO
General		
Ammunition storage	GT	GT
Aviation ordnance	EL	GT
Basic baker	GT	GT
Basic food service	GT	GT

[a]Taken from Recruit Distribution Model dictionary of 27 January 1981.

TABLE 12

COMBINATIONS[a] OF CORRECTED VALIDITY COEFFICIENTS[b] FOR ASVAB COMPOSITES

Course	Best predictive composite	Best two composites	Best three composites	Validity of combinations of: One	Two	Three
Basic supply stock clerk	FA	FA, GT	FA, GT, SC	54	55	56
Personal financial records clerk	ST	ST, GT	ST, GT, CO	58	61	62
Basic automotive mechanic	MM	MM, GM	MM, GM, OF	65	67	68
Advanced automotive mechanic	GM	GM, MM	GM, MM, CO	66	67	68
Basic baker	EL	EL, GCT	EL, GCT, GM	58	59	59
Basic food service	EL	EL, CO	EL, CO, GCT	56	57	57
Combat engineer	GM	GM, FA	GM, FA, CO	66	67	67
Basic electrician	MM	MM, GT	MM, GT, GCT	45	48	49
Electrical equipment repairman	FA	FA, GT	FA, GT, CL	38	39	42
Basic engineer equipment mechanic	GM	GM, SC	GM, SC, GCT	62	64	65
Administrative clerk	EL	EL, CL	EL, CL, GT	55	58	58
Personnel clerk	FA	FA, CL	FA, CL, OF	56	58	58
Unit diary clerk	GT	GT, FA	GT, FA, GM	56	57	58
Sea duty indoctrination	FA	FA, CL	FA, CL, MM	48	50	50
Basic electronics	EL	EL, GT	EL, GT, FA	61	63	63
Radio fundamentals	EL	EL, GT	EL, GT, CL	44	46	49
Field radio operator	EL	EL, CL	EL, CL, GM	49	51	52
Communication center man	ST	ST, GT	ST, GT, FA	55	57	57
Infantry training	EL	EL, CO	EL, CO, OF	34	35	36
Tracked vehicle repair	GCT	GCT, SC	GCT, SC, GM	75	87	94
Basic helicopter	GM	GM, FA	GM, FA, MM	54	56	57
Aviation structural mechanic (safety equipment)	FA	FA, CO	FA, CO, GT	52	55	56
Aviation structural mechanic (hydraulics)	GM	GM, CO	GM, CO, SC	60	62	62
Aviation structural mechanic (structures)	EL	EL, CL	EL, CL, MM	53	55	56
Aviation ordnance	EL	EL, GCT	EL, GCT, MM	52	53	55
Aviation crash crew	EL	EL, CO	EL, CO, MM	46	48	49
Avionics repairman	GT	GT, MM	GT, MM, EL	62	66	66
Aviation operations (clerical)	GCT	GCT, GT	GCT, GT, CL	47	51	54
Aviation maintenance adminstration	EL	EL, GT	EL, GT, OF	52	54	54
Aviation supply (mechanical)	FA	FA, CL	FA, CL, ST	58	60	61
Small arms repair	CO	CO, SC	CO, SC, GT	49	50	52
Ammunition storage	FA	FA, CO	FA, CO, OF	57	59	60
Basic cannoneer	GM	GM, ST	GM, ST, SC	53	55	55
Mean				54	57	58

[a] From stepwise regression analysis of ASVAB composites used by the Marine Corps.
[b] Multiplied by 100.

and three composite combinations (best in this context means highest validity coefficient). The mean value of the best single composite was 0.54. The best two-composite and three-composite combinations gave mean validities of 0.57 and 0.58, respectively. This small increase in predictive power is achieved at the cost of a greatly reduced pool of recruits qualified for courses (table 13). The use of two selector composites instead of one typically reduces the qualified pool by 20 to 40 percent. If the procedure is used for one course, that one course may achieve slightly better performance at the expense of reduced performance in the other courses. If all courses use the multiple composite procedure it negates the benefits of a differential test battery and becomes self-defeating. We recommend the use of one and only one composite for selection to schools.

TABLE 13

ILLUSTRATION OF EFFECT OF MULTIPLE COMPOSITES ON SUPPLY OF ELIGIBLE RECRUITS

Selection	Percentage of recruits eligible[a]	Percentage reduction[b] in eligible recruits due to multiple requirements
EL ≥ 100	46.6	
EL and GT ≥ 100	36.6	21.4
EL ≥ 120	13.9	
EL and GT ≥ 120	8.7	37.4

[a]Sample of 26,666 high school graduate Marine Corps recruits enlisted in CY 1979.

[b]Percentage reduction from number eligible with single composite requirement.

OTHER SERVICE COMPOSITES

A comparison of the validity of composites used by the Marine Corps* with those of other services is given in table 14. The mean validities for Marine Corps and Army composites were 0.54, which compares well with the mean of 0.50 for the Air Force and 0.56 for Navy composites.

* There is almost total overlap in the sets of composites used by the Army and Marine Corps so the results for these two services were combined.

TABLE 14

LARGEST CORRECTED VALIDITY COEFFICIENTS[a]
FROM EACH SERVICE SET OF COMPOSITES

Course	Marine Corps/ Army	Air Force	Navy
Basic supply stock clerk	54	45	57
Personal financial records clerk	58	51	62
Basic automotive mechanic	65	64	65
Advanced automotive mechanic	66	63	69
Basic baker	58	52	60
Basic food service	56	50	55
Basic combat engineer	66	64	65
Basic electrician	45	44	49
Electrical equipment repairman	38	30	38
Basic engineer equipment mechanic	62	60	59
Administrative clerk	55	52	57
Personnel clerk	56	52	54
Unit diary clerk	56	46	55
Sea duty indoctrination	48	51	50
Basic electronics	61	46	67
Radio fundamentals	44	31	47
Field radio operator	49	49	53
Communication center man	55	52	57
Infantry training	34	32	34
Tracked vehicle repair	75	67	66
Basic helicopter	55	52	58
Aviation structural mechanic (safety equipment)	52	47	55
Aviation structural mechanic (hydraulics)	60	60	65
Aviation structural mechanic (structures)	53	52	58
Aviation ordnance	52	44	58
Aviation crash crew	46	49	44
Avionics repair	62	49	68
Aviation operations (clerical)	47	46	42
Aviation maintenance administration	52	52	57
Aviation supply (mechanical)	58	55	58
Small arms repair	49	50	42
Ammunition storage	57	55	61
Basic cannoneer	53	48	51
Mean	54	50	56

[a]Multiplied by 100.

VALIDITY OF AFQT

Three tests in ASVAB 6/7 are combined to form the Armed Forces Qualification Test (AFQT) score. This score has traditionally been used by the services as a measure of general trainability. The AFQT score is also the basis of the AFQT mental categories on which the general overall mental ability of service personnel is reported to Congress. Recently the AFQT score has been criticized as having no value as a predictor of success in military occupations [9]. In light of this allegation, we examined the predictive power of the AFQT part of the battery. Because the AFQT score is simply the GCT composite expressed in percentile score form, the validity coefficients already calculated for GCT (table 8) will also apply to AFQT. We express predictive power as the square of the validity coefficient for AFQT as a percentage of the square of the largest validity coefficient of all 11 composites in table 8. The results are summarized in table 15. A conservative estimate is that at least 80 percent of the predictive power of the entire ASVAB is contained within the AFQT component. Allegations that AFQT is useless appear to be without foundation.

TABLE 15

PREDICTIVE POWER OF AFQT

Group	Mean validity coefficient[a]		Percentage of predictive power of battery in AFQT[c]
	Largest	AFQT[b]	
Mechanical	56	53	89
Electrical	48	45	88
Clerical	53	51	93
Field artillery	53	48	82
Combat	41	36	77
General	56	47	70
Mean			83

[a] From table 8.
[b] AFQT is made up of the same tests as GCT.
[c] $\left(\frac{\text{Square of AFQT validity coefficient}}{\text{Square of largest validity coefficient}}\right) \times 100$

EFFECT OF EDUCATION, RACE, AND SEX ON VALIDITY

Ideally, ASVAB scores should predict performance equally for all groups in the population. Because this goal is not easily attainable it

is reasonable to examine ASVAB in this context. To the extent that individuals with identical ASVAB scores, but different personal characteristics, perform differently in courses, the ASVAB may be said to underpredict success for some groups. Underprediction for a certain group is commonly referred to as test bias against that group.

Underprediction is illustrated in figure 1. The solid lines represent the relationship usually observed between performance in training courses and ASVAB scores (in this instance the GT composite is shown). Separate lines are shown for high school graduates and non-high school graduates. Ideally the two lines should fall on top of one another. In this illustration they do not; hence, we have underprediction for high school graduates. Reference to figure 1 shows that recruits with GT scores of 100 will achieve a final course grade of about 80 (if they are non-high school graduates) and about 87 (if they are high school graduates). High school graduates will outperform non-high school graduates with the same GT score. For this reason the ASVAB may be said to underpredict the performance of high school graduates (or alternately to overpredict the performance of non-high school graduates).

In appendix F we examine the relationship between course performance, ASVAB scores, civilian educational level, race, and sex. The effects found (after controlling for ASVAB scores) are summarized in table 16. The analysis is restricted to those courses with 100 or more cases in each population group of interest. The analysis indicates that course performance of high school graduates is underpredicted for almost every course. The mean equivalent composite score points of underprediction is 13. This means that, on the average, high school graduates perform like nongraduates who are 13 points more able as measured by the appropriate ASVAB composite. Because of the size and consistency of the effect we recommend that compensating action be taken in recruit assignment.

The situation with respect to a possible racial effect is less clear. In about half of the courses examined no racial effect was found. In the other half of the courses the ASVAB was found to underpredict the performance of whites. Because the average effect of the underprediction is small and not consistent over all courses, we recommend that no corrective action be taken. The data are conclusive, however, that the ASVAB is not biased against minorities.

Because there were only two courses with sufficient female recruits for analysis no definitive conclusions can be drawn with regard to underpredition by sex. In one of the two courses a significant underprediction of female performance was found--in the other it was not. Because the overall effect is small and not consistent over all courses, we recommend that no corrective action be taken.

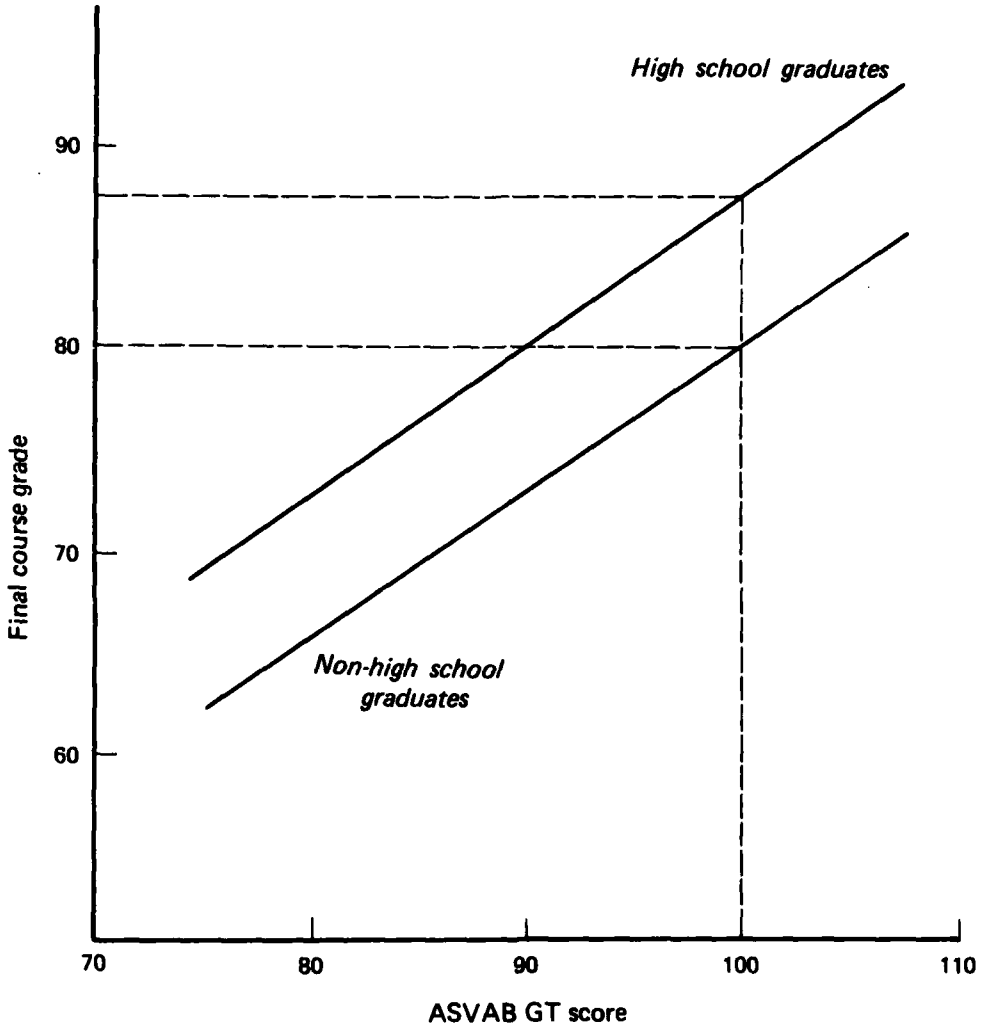


FIG. 1: ILLUSTRATION OF UNDERPREDICTION

TABLE 16

EFFECT OF CIVILIAN EDUCATION, RACE, AND SEX
ON COURSE PERFORMANCE

Variable	Number of courses[a]	Number of courses in which variable was significant[b]	Mean equivalent composite score points[c,d] underpredicted	Group for which performance is underpredicted
Education	16	15	13	Graduates
Race	15	8	6	Whites
Sex	2	1	4	Females

[a]Courses in which each population group contained 100 or more cases.
[b]Significant at the 99 percent confidence level.
[c]Number of composite score points to which membership in the better performing group is equivalent.
[d]In computing the mean, courses for which the variable was not significant were assigned zero equivalent score points.

CHAPTER 4

ESTIMATED VALIDITY OF ASVAB 8/9/10 COMPOSITES

All the validity data used in this analysis is based on ASVAB 6/7 test scores. ASVAB 6/7 was replaced at the AFEES by ASVAB 8/9/10 on 1 October 1980. For this reason the results of this analysis are primarily of interest to the extent that they can be generalized to apply to ASVAB 8/9/10.

To evaluate the generalizability of our results we first compare the tests in ASVAB 6/7 with those in ASVAB 8/9/10. We then examine the comparability of liked-named composites in the two batteries. Last, we simulate ASVAB 8/9/10 composites in our ASVAB 6/7 data set and use scores on these simulated composites to estimate ASVAB 8/9/10 validities for representative courses.

The structure of ASVAB 8/9/10 is summarized in table 17.

TABLE 17

THE STRUCTURE OF ASVAB 8/9/10

Subtest	Content area	Number of questions	Testing time (minutes)
GS	General Science	25	11
AR[a]	Arithmetic Reasoning	30	36
WK[a]	Word Knowledge	35	11
PC[a]	Paragraph Comprehension	15	13
NO[a]	Numerical Operations	50	3
CS	Coding Speed	84	7
AS	Auto and Shop Information	25	11
MK	Mathematics Knowledge	25	24
MC	Mechanical Comprehension	25	19
EI	Electronics Information	20	9
		334	144

[a]These tests comprise the AFQT part of the battery:

$$AFQT = AR + WK + PC + \left(\frac{NO}{2}\right) .$$

COMPARISON OF ASVAB 6/7 AND ASVAB 8/9/10 TESTS

A comparison of the test structure of the two batteries is given in table 18. Based on validity information available in 1979 the ASVAB Working Group* restructured the ASVAB by eliminating those test content areas that appeared to add little or no unique predictive power to the battery (GI, AD, SP, CC, CA, CE, and CM). The battery was strengthened by adding the Paragraph Comprehension (PC) test and the Coding Speed (CS) test. The tests in ASVAB 8/9/10 generally contain a larger number of items than did the like-named test in ASVAB 6/7.

TABLE 18

COMPARISON OF STRUCTURE OF ASVAB 6/7 AND ASVAB 8/9/10

Content area	Symbol	Present in ASVAB 8/9/10	Present in ASVAB 6/7
General Science	GS	✓	✓
Arithmetic Reasoning	AR	✓	✓
Word Knowledge	WK	✓	✓
Paragraph Comprehension	PC	✓	
(Verbal = PC + WK)	VE	✓	
Numerical Operations	NO	✓	✓
Coding Speed	CS	✓	
Auto & Shop Information	AS	✓	✓[a]
Mathematics Knowledge	MK	✓	✓
Mechanical Comprehension	MC	✓	✓
Electronics Information	EI	✓	✓
General Information	GI		✓
Attention to Detail	AD		✓
Spacial Perception	SP		✓
Combat Scale	CC		✓
Attentiveness Scale	CA		✓
Electronics Scale	CE		✓
Maintenance Scale	CM		✓

[a]In ASVAB 6/7, Auto and Shop Information were scored separately.

* A joint service group that deals with ASVAB issues. It is composed of one policy and one technical representative from each service.

The tests that were retained* in ASVAB 8/9/10 exhibit correlations of approximately 0.8 with like-named tests in ASVAB 6/7 (table 19). Because most of the tests in ASVAB 6/7 were rather short (only 20 items) this level of correlation appears to be very satisfactory.

TABLE 19

CORRELATIONS BETWEEN LIKE-NAMED TESTS IN ASVAB 6/7 AND ASVAB 8/9/10

Tests		Correlation[a]
ASVAB 6/7	ASVAB 8/9/10	coefficient
GS	GS	0.81
AR	AR	0.86
WK	VE	0.87
NO	NO	0.78
AI/SI	AS	0.80[b]
MK	MK	0.84
MC	MC	0.81
EI	EI	0.78

[a]Computed from a stratified sample of 2,025 applicants from all services tested at AFEES.
[b]Computed as the mean of correlations for AI:AS of 0.83 and SI:AS of 0.77.

Test content areas that demonstrated validity were retained in the transition from ASVAB 6/7 to ASVAB 8/9/10. ASVAB 8/9/10 tests correlate well with the like-named ASVAB 6/7 tests in each content area. Therefore we expect that the potential validity of ASVAB 8/9/10 should be as good as that of ASVAB 6/7-perhaps even somewhat better due to the addition of PC and CS.

* Actually only the content areas were retained. The tests themselves were replaced with like-named tests containing similar (but not identical) questions.

COMPARISON OF ASVAB 6/7 AND ASVAB 8/9/10 COMPOSITES

Recruit assignments are made on the basis of scores achieved on ASVAB composites. For this reason the validity actually realized from the battery depends on the validity of the composites.

Because some of the tests in ASVAB 6/7 were eliminated with the transition to ASVAB 8/9/10, the new aptitude composites are defined differently. Based on information available in 1979 [1, 2, and 3] the Marine Corps chose a set of interim composite definitions for ASVAB 8/9/10. The test content of the ASVAB 8/9/10 composites is compared with that of like-named ASVAB 6/7 composites in table 20.

TABLE 20

COMPARISON OF USMC ASVAB 6/7 AND ASVAB 8/9/10 COMPOSITE STRUCTURE

		Test content of composites	
Composite	Symbol	ASVAB 8/9/10	ASVAB 6/7[a]
General Maintenance	GM	GS + MK + AS + EI	GS + AR + MC + AI
Mechanical Maintenance	MM	AR + AS + MC + EI	MK + SI + AI + EI + CM
Electronics	EL	GS + AR + MK + EI	GS + AR + MK + EI
Clerical	CL	VE + NO + CS	WK + AR + AD + CA
Field Artillery	FA	VE + AR + AS	GI + AR + MK + EI + CA
Combat	CO	VE + NO + AS	AR + SI + SP + AD + CC
General Technical	GT	VE + AR	WK + AR
General Classification Test	GCT	[b]	WK + AR + SP

[a]The composites OF, ST, and SC were computed for ASVAB 6/7 but not actually used in recruit assignment. For ASVAB 8/9/10 they are not computed.

[b]Not computed for ASVAB 8/9/10.

The definitions of the ASVAB 8/9/10 composites appear to differ significantly from those of the like-named ASVAB 6/7 composites. This difference is, however, not as large as it appears. The like-named composites do tap similar content areas and correlate reasonably well.

Correlations between ASVAB 6/7 and ASVAB 8/9/10 composites are shown in table 21. In chapter 3 we concluded that GM and MM were not both necessary for mechanical courses and that GM was preferable because it had a somewhat higher mean validity. During the formulation of the interim ASVAB 8/9/10 composites the definitions of MM and GM were changed so that most of the subtest content that was in the ASVAB 6/7 GM was moved into the ASVAB 8/9/10 MM composite. For this reason and because GM in ASVAB 6/7 correlates best (0.93) with MM in ASVAB 8/9/10, we recommend MM as the interim ASVAB 8/9/10 composite for mechanical courses.

TABLE 21

CORRELATIONS BETWEEN USMC ASVAB 6/7 AND ASVAB 8/9/10 COMPOSITES

	Correlations[a] between ASVAB 6/7 composite and:	
ASVAB 6/7 composite	Like-named ASVAB 8/9/10 composite	Highest correlate in ASVAB 8/9/10
GM	.92	.93 (MM)[b]
MM	.89	.89 (MM)[b]
EL	.94	.94 (EL)[b]
CL	.79	.86 (GT)[b]
FA	.90	.92 (EL)[b]
CO	.79	.83 (MM)[b]
GT	.91	.91 (GT)[b]
GCT	-[a]	.90 (GT)[b]

[a]Computed from a stratified sample of 2,025 applicants for enlistment from all services.
[b]ASVAB 8/9/10 composite having highest correlation with indicated ASVAB 6/7 composite.
[c]GCT is not computed for ASVAB 8/9/10.

The EL composite in ASVAB 8/9/10 is seen (table 21) to correlate well (0.94)* with the EL composite in ASVAB 6/7 and should be suitable as a selector for electronics courses. The correlation between the CL composite in ASVAB 6/7 and the CL composite in ASVAB 8/9/10 is rather

* Because the structure of the EL composite was not changed in the transition from ASVAB 6/7 to ASVAB 8/9/10, the observed correlation of 0.94 may be taken as a measure of the reliability of the ASVAB 8/9/10 composites.

low (0.79). This indicates that the validity of the CL composite in ASVAB 8/9/10 is likely to be different (either better or worse) than it was in ASVAB 6/7. (We return to the question of the validity of CL later.) The FA composite from ASVAB 8/9/10 correlated 0.90 with its like-named composite in ASVAB 6/7 and should be a satisfactory replacement. The CO composite in ASVAB 8/9/10 correlates only 0.79 with its like-named composite in ASVAB 6/7 and, hence, may produce somewhat different validity results. Because none of the ASVAB 6/7 composites had particularly high validity for combat training, the 0.79 correlation for CO composite is not likely to be troublesome. We recommend the use of the interim CO composite. The GCT composite from ASVAB 8/9/10 correlates 0.91 with the like-named composite in ASVAB 6/7 and should be a suitable replacement. The GCT composite is not computed in ASVAB 8/9/10. Because GCT in ASVAB 6/7 correlates 0.90 with GT in ASVAB 8/9/10 we recommend GT as an appropriate replacement for GCT.

ESTIMATED VALIDITY OF ASVAB 8/9/10

Most of the tests used in the ASVAB 8/9/10 composites were also included in ASVAB 6/7. Therefore, we can simulate ASVAB 8/9/10 composites in our ASVAB 6/7 data set and calculate estimates of their validity. We have carried out this calculation for three representative courses with large sample sizes in the mechanical, electrical, and clerical areas. The formulations of the actual and simulated ASVAB 8/9/10 composites are given in table 22.

Estimated validity coefficients were calculated for the three representative courses and are shown in table 23. The estimated validities for ASVAB 8/9/10 are as good as or better than they were for ASVAB 6/7 except in the case of the CL composite, which is slightly lower. Because the validity of the CL composite in ASVAB 6/7 was already somewhat lower than desirable (table 8) this result is disturbing and indicates that the formulation of the CL composites should be revised as soon as possible. A suggested formulation for CL that would improve its validity is given in chapter 6.

TABLE 22

SIMULATED ASVAB 8/9/10 COMPOSITES

Course grouping	ASVAB 8/9/10 composite	Simulated ASVAB 8/9/10 composite
Mechanical (MM)	AR + AS + MC + EI	$AR + \frac{(SI + AI)}{2} + MC + EI$
Electrical (EL)	GS + AR + MK + EI	GS + AR + MK + EI
Clerical (CL)	VE + NO + CS	WK + 2(NO)[a]

[a]NO is the test with the highest correlation with CS (0.64).

TABLE 23

ESTIMATED VALIDITY OF ASVAB 8/9/10 COMPOSITES FOR THREE REPRESENTATIVE COURSES

		Validity[a]	
Course	Composite	ASVAB 6/7	Simulated ASVAB 8/9/10
Basic auto mechanics	MM	0.65	0.71
Basic electronics	EL	0.61	0.61
Administrative clerk	CL	0.53	0.49

[a]Corrected for restriction of range.

COMPOSITES FOR ASVAB 8/9/10

We have seen that, except for the change from GM to MM, the like-named composites recommended for ASVAB 6/7 (table 11) are appropriate for ASVAB 8/9/10. This recommendation is summarized in table 24. We expect that the validity of these ASVAB 8/9/10 composites will be similar to that observed for the ASVAB 6/7 composites.

TABLE 24

ASVAB 8/9/10 COMPOSITES RECOMMENDED FOR USE BY USMC

Course content area	Recommended ASVAB 8/9/10 composite
Mechanical	MM
Electrical	EL
Clerical	CL
Field Artillery	FA
Combat	CO
General	GT

CHAPTER 5

COMPOSITE SCORE PREREQUISITES FOR ASVAB 8/9/10

In this chapter we take the aptitude selector composite for each course to be that recommended in chapter 4 and address the question of what should be the minimum composite score for assignment to each entry-level course. Clearly, the setting of minimum prerequisties (cut scores) involves personal judgment as well as analysis. The resulting cut scores, therefore, should be viewed as reasonably accurate, but not precisely determined points.

CORRECT NORMALIZATION OF ASVAB

As previously noted, the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) determined in July 1980 that the normalization of ASVAB 6/7 had been in error since January 1976 [4]. The error was in such a direction as to inflate the ASVAB scores of recruits. The analysis discussed in this chapter uses test scores from ASVAB 6/7. However, these ASVAB 6/7 scores have all been adjusted to reflect the correct [5] normalization of ASVAB 6/7. With this adjustment, both ASVAB 6/7 and ASVAB 8/9/10 scores are scaled to the same traditional reference population and may be viewed as equivalent. Cut scores that are found to be appropriate from ASVAB 6/7 data should be appropriate for use with ASVAB 8/9/10.

Because ASVAB 8/9/10 is correctly normed, recruits at a given score level on ASVAB 8/9/10 will perform better than recruits at that same score level on the incorrectly normed ASVAB 6/7. Therefore, expectations of future recruit performance in training schools should be adjusted upward even if current nominal prerequisite levels remain unchanged. Figure 2 illustrates observed failure rates in the Basic Electronics Course as a function of EL composite scores calculated using both the incorrect and the correct norms. The observed failure rate at each score level is seen to be lower for scores calculated on the basis of correct norms.

The error in the original norming of ASVAB 6/7 did have one positive effect. It afforded us the opportunity to observe the performance of low aptitude recruits who, had the normalization been correct, would not have qualified for enlistment. These low aptitude recruits are included in the data used in this analysis.

RECENT CHANGES IN PREREQUISITES

Prerequisites used for Marine Corps training courses have traditionally been stable. They have, however, undergone two major changes since 1975. These changes were due to the misnorming of ASVAB 6/7

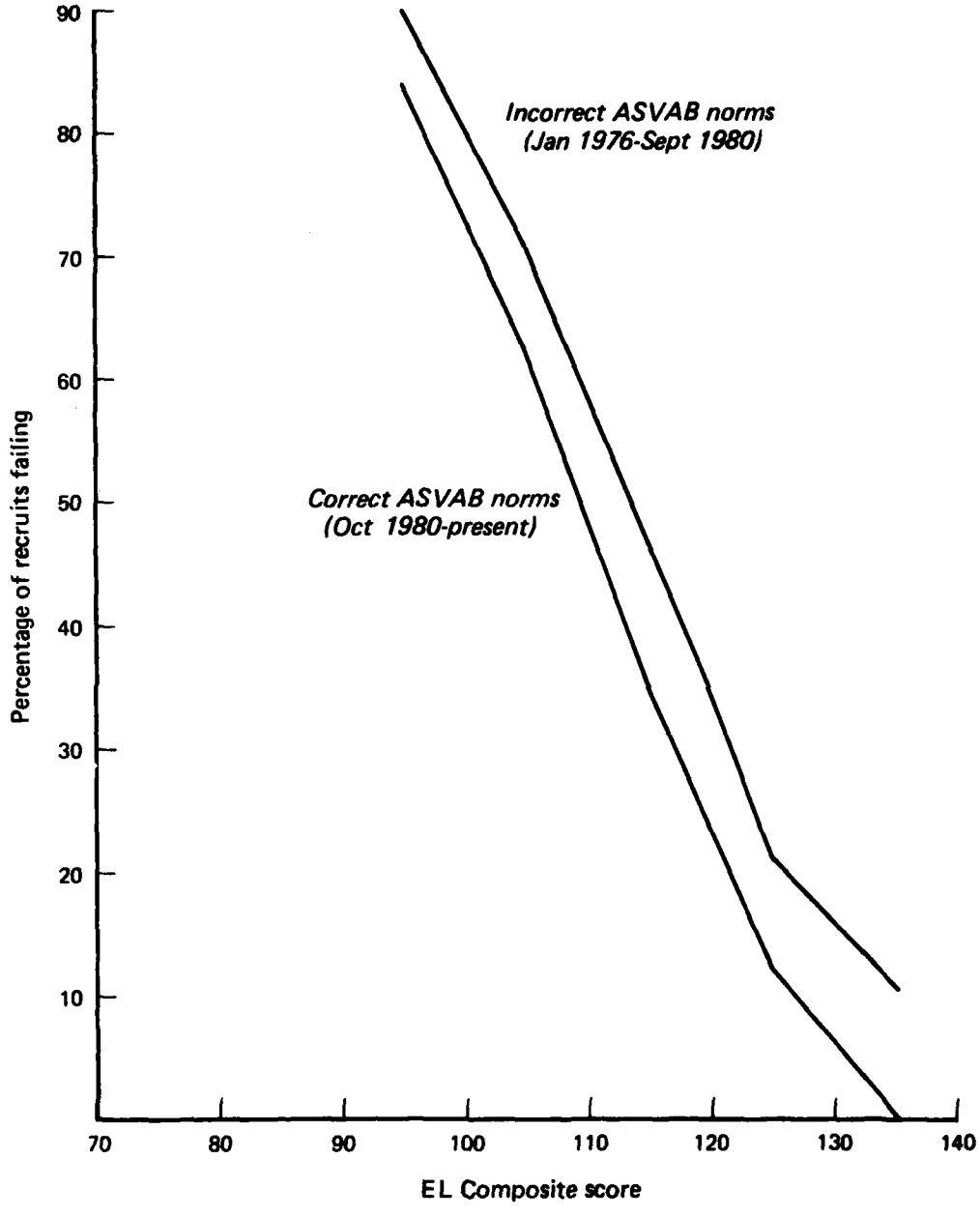


FIG. 2: COMPARISON OF FAILURE RATES IN BASIC ELECTRONICS BY NORMS USED TO COMPUTE APTITUDE SCORE

and to efforts to compensate for the underprediction, by ASVAB, of high school graduate performance.

The use of incorrect norms for ASVAB 6/7 from January 1976 through September 1980 inflated the ASVAB scores of recruits. This inflation of ASVAB scores effectively lowered real prerequisites from 4 to 10 composite score points* below previous levels [10].

An analysis conducted in 1977 [11] showed that high school graduates outperform non-high school graduates with identical aptitude scores. In 1978 the Marine Corps, following the recommendations of [11], adjusted training prerequisites to compensate for this difference in performance. This adjustment consisted of lowering prerequisites for high school graduates by 10 composite score points while maintaining those of non-high school graduates at their previous level.

The combined effect of these two changes was to lower prerequisites by as much as 20 composite points for high school graduates and as much as 10 composite score points for non-high school graduates. The decrement in prerequisites due to misnormed tests was removed in October 1980 with the introduction of the correctly normed ASVAB 8/9/10 [12 and 13]. However, the decrement due to lower standards for high school graduates is still in effect.

COURSE FAILURE RATES

The primary goal in setting test score prerequisites for training courses is to ensure that recruits assigned to these courses have a reasonable probability of successfully completing the course.** The maximum acceptable failure rate has, to the best of our knowledge, never been analytically determined; but is generally considered to be about 10 percent.

The failure rates observed for entry level courses attended by Marine Corps recruits in FY 1980 are summarized in table 25. We see, for example, that 32 percent of the courses had failure rates of less than 5 percent. Table 25 also shows that 48 percent of all courses had failure rates of 10 percent or more. To the extent that a 10 percent failure rate is a reasonable goal, it appears that either many current prerequisites are too low or that the course content is too hard.

* ASVAB composites used by the Marine Corps are scaled to have approximately a mean of 100 and a standard deviation of 20 in the traditional reference population.

** Performance on the job is a separate issue, but it has generally been assumed that recruits who successfully complete the training courses are qualified to perform their military job.

TABLE 25

DISTRIBUTION OF FY 1980 COURSE FAILURE RATES

Failure rate interval (percentage failing)	Percentage[a] of all courses
0.0 - 4.9	32
5.0 - 9.9	20
10.0 - 14.9	16
15.0 - 19.9	9
20.0 - 24.9	12
25.0 - 29.9	5
≥ 30.0	6
	100

Source: Headquarters Marine Corps Training Division [14].

[a]Percentage of all 86 courses for which data were available.

In this report we assume that course content and instructional methodology are not going to change radically in the near future. We therefore have attempted to determine prerequisites that will be appropriate under the present circumstances.

RECRUIT DISTRIBUTION MODEL

The Recruit Distribution Model (RDM) is the mechanism whereby recruits are assigned to specific training courses that best match their aptitudes as measured by ASVAB scores, the needs of the Marine Corps, and previously guaranteed training commitments. These considerations are brought together in the RDM dictionary. For illustration the RDM dictionary listing for the Basic Electronics Course (BEC) is reproduced in table 26. Note from table 26 that there are two levels of prerequisites shown for BEC. The "mandatory" level requires high school algebra, an EL score of 100, a GT score of 110, high school diploma, security clearance, and color vision. The mandatory prerequisites represent the minimum acceptable level. The preferred qualifications for this course are expressed by the "desirable" level, which includes all the mandatory prerequisites plus an EL score of 110 and a 4-year enlistment. Once the RDM determines an allocation of recruits that will fill all essential school seats at the mandatory level, recruits are shifted among various assignments for which they qualify to maximize the resulting mean value of the selector area aptitude (AA score) that has

been designated as the best predictor of success in each course. In the case of BEC, the selector area aptitude is GT (see table 26).

TABLE 26

ILLUSTRATION OF RECRUIT DISTRIBUTION MODEL DICTIONARY FOR BASIC ELECTRONICS COURSE

Prerequisites (for high school graduates only)[a]		Selector area aptitude composite (AA score)
Mandatory	Desirable	
EL 100	EL 110	GT[b]
GT 110	GT 110	
High school algebra	High school algebra	
High school graduate	High school graduate	
Security clearance	Security clearance	
Color vision	Color vision	
	4-year enlistment	

[a]Non-high school graduates are not assigned to this particular course. However, if they were, their test score prerequisites would be 10 points higher than those shown in this table.

[b]Once a pool of recruits who meet the minimum prerequisites for each course has been identified the recruits are shifted among various possible assignments for which they are qualified in an effort to maximize the selector area aptitude composite designated for each course.

There are some courses for which the selector area aptitude composite (table 26) has not been chosen to be the same composite as the one used to define the mandatory prerequisite level. This practice will result in nonoptimal recruit classification and should be discontinued.

DECISION RULES FOR PREREQUISITE SELECTION

Performance (both training and job performance) tend to be smoothly varying functions of aptitude test scores. For this reason it is generally difficult (perhaps impossible) to determine a point on an aptitude test such that most individuals above that point will subsequently be successful and most individuals below that point will prove to be unsuccessful. It is particularly difficult in the present case, because detailed information on individual performance is not available for all training courses. For some other courses the training performance criteria are suspect.

The setting of prerequisites is further complicated by reactions to the two inadvertent lowerings of prerequisites discussed earlier in this chapter. Some training schools viewed trainee quality unsatisfactory and requested relief in the form of increased prerequisites. Some schools were granted relief and others were not.

In view of these uncertainties we adopted a conservative approach to setting prerequisites. We took as a starting point the prerequisite levels in use during the generally stable period prior to 1976. We then reviewed these prerequisites and made changes in their level only if available data provided strong evidence for change Our guidelines may be summarized as follows:

- Use traditional (pre-1976) prerequisite levels unless there is strong evidence to the contrary
- For courses in which change is dictated, set prerequisites so that no more than:
  - 10 to 20 percent of recruits in the lowest composite interval will fail
  - 5 to 10 percent of the class will fail.

INFORMATION SOURCES

The information sources used to determine prerequisites are as follows:

- Traditional (pre-1976) prerequisite levels [15]
- Pass/fail percentages by composite score interval for 46 courses during CY 1977-1978
- Pass/fail percentages for 86 entry level courses during FY 1980 [14]
- Course content specified in USMC Formal Schools Catalog [16]
- Job requirements specified in USMC Military Occupational Specialities (MOS) Manual [17].

SELECTION OF PREREQUISITES SCORE LEVELS

We will illustrate our selection of prerequisite score levels by describing the process for five representative courses. These courses are Basic Supply Stock Clerk, Basic Electronics, Basic Helicopter Maintenance, Airborne Radio Operator, and Freight Transportation Clerk. Prerequisites for other courses were determined in a similar manner. Data used in the selection procedure are tabulated in appendix G.

Basic Supply Stock Clerk

Figure 3 shows failure rates by score interval for Basic Supply Stock Clerk and two other courses. The graph for Basic Supply Stock Clerk shows that the failure rate of recruits decreases as the composite score increases. The pre-1976 prerequisite level for this course was 100 and the current level is 110.* Figure 3 shows that recruits at a composite score of 110 experience a failure rate of about 19 percent. Figure 4 shows the failure rate to be expected for the entire course if the recruit input were restricted to those at or above the indicated composite score. Reference to figure 4 shows that a minimum composite score of 110 should produce a class failure rate of about 10 percent. Because these failure rates are within our guidelines we recommend a prerequisite level of 110 for this course.

Basic Electronics

Recruit failure rates by composite score interval and class failure rates by minimum composite score are shown for the Basic Electronics Course in figures 3 and 4. Both the current and pre-1976 prerequisite levels for this course are 110. We see from figure 3 that about 47 percent of recruits at this level are expected to fail the course. We view this as too high and recommend a prerequisite of 115 for this course. Figures 3 and 4 show that about 33 percent of the recruits at this level will fail and that about 16 percent of the entire class will fail. We note that these projected failure rates are higher than our guidelines. To meet our guidelines a prerequisite level of 120 would be required. If recruit supply were not a consideration then 120 would be an appropriate level. However, given the present supply situation we are reluctant to raise the prerequisites for this course to such a level as to absorb a larger percentage of the high aptitude recruits. At this time, we view 115 as an appropriate prerequisite level for this course.

Basic Helicopter Maintenance

We see from figures 3 and 4 that the failure rate for this course seems to be independent of composite score. Figure 5 shows that the failure rate on the first attempt at the course does show the expected dependence on composite score. The figure also shows that it is possible for most of the lowest aptitude recruits to pass the course after repeated attempts. Whether those who pass only after repeated attempts perform well on the job after graduating is an open question. The pre-1976 prerequisite level for this course was 100 and the current level is 85. From references 16 and 17 we conclude that the course content is substantive and that the course graduates are expected

* All prerequisite levels discussed in this chapter will be those appropriate for high school graduates. Current prerequisite levels for non-high school graduates are higher by 10 composite score points.

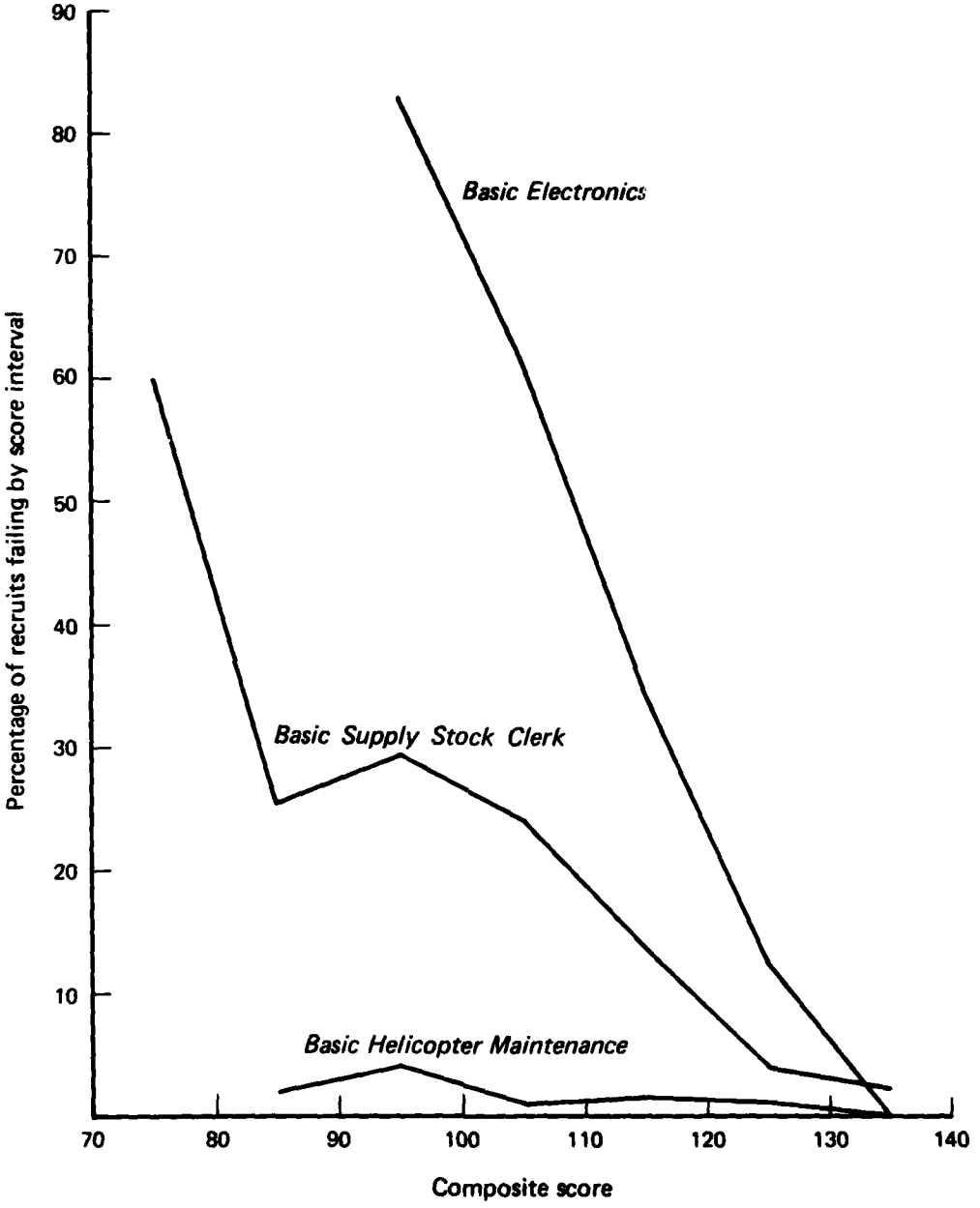


FIG. 3: ILLUSTRATION OF FAILURE RATES BY COMPOSITE SCORE INTERVAL

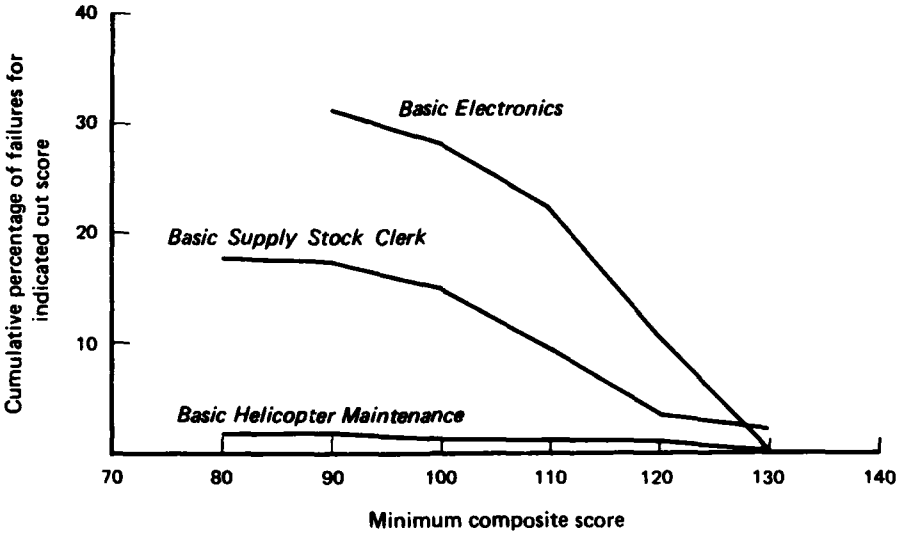


FIG. 4: ILLUSTRATION OF CLASS FAILURE RATE BY COMPOSITE CUT SCORE

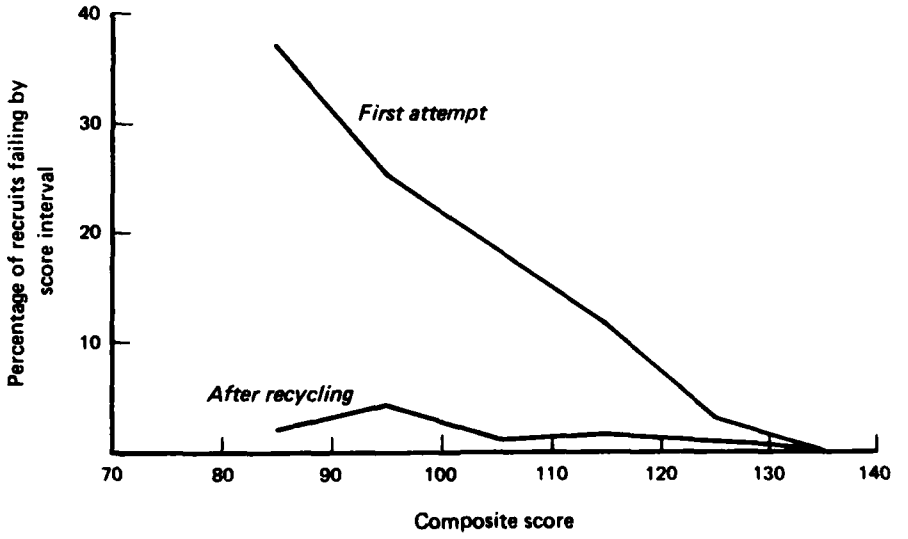


FIG. 5: ILLUSTRATION OF EFFECT OF RECYCLING ON FAILURE RATE IN BASIC HELICOPTER MAINTENANCE COURSE

to perform critical work. We therefore conclude that there is no reason to change the pre-1976 prerequisite level of 100.

Airborne Radio Operator

Failure rates by composite interval are not available for this course. The only data available consists of a single failure rate for all recruits who entered the course in FY 1980. That failure rate (shown for this and 85 other courses in appendix G) was 24 percent. The present prerequisite for this course is 100 while the pre-1976 level was 110. We consider the 24 percent failure rate to be excessive and recommend a return to the pre-1976 level of 110.

Freight Operations Clerk

There are no failure rate data available for this on-the-job training course. The present prerequisite level is 80 as was the pre-1976 level. From a review of the job requirements as set forth in [17] we conclude that this is an appropriate prerequisite for this course.

RECOMMENDED PREREQUISITE LEVELS

Prerequisites for all entry level courses were examined as illustrated by the examples shown in the previous section. The courses and their RDM assignment symbol, pre-1976 prerequisite level, current prerequisites, and our recommended prerequisites are shown in table 27.

Our recommendations shown in table 27 apply to high school diploma graduates only. We recommend prerequisites 10 composite points higher for non-high school graduates.

Validity data on ASVAB 8/9/10 using both training and job performance measures are likely to be available within a few years. At that time it would be reasonable to update the prerequisites shown in table 27.

COMPARISON OF TEST LEVELS IN MILITARY AND CIVILIAN JOBS

During World War II (WWII) a large and presumably representative group of men entered military service. These men came from a wide variety of civilian occupations. Reference [18] reports on a study of the relationship between civilian occupation and test scores on the Army General Classification Test (AGCT). The data used for the study is based on 81,553 white army enlisted men from 227 different civilian occupations.

TABLE 27

SUGGESTED APTITUDE TEST PREREQUISITES FOR ASVAB 8/9/10

Course Title	RDM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates[a]		Proposed Prerequisites for High School Graduates[a]	
				Mandatory	Desirable	Mandatory	Desirable
Air Traffic Controller	AGAC[b]	7311	110	GT(100)	GT(110)	GT(110), HS[a,a]	GT(110), HS
Advanced Auto Mechanic	ADVMECH	3500	-	GT(90), GM(90)	GT(99), GM(90)	MM(100)	MM(100)
Air Control Electronics Operator	AGACEL	7234	100	GT(90)	GT(100)	GT(100)	GT(110)
Machinists Mate	AGADA	6000	95	GT(85)	GT(90), GM(100)	MM(100)	MM(100)
Aerographers Mate	AGAG	6821	105	GT(90), CL(95), AR(11)	GT(100), CL(100), AR(11)	GT(110)	GT(110)
Aviation Structural Mechanic (S, H, E)	AGAM	6000	95	GT(85), GM(80)	GT(90), GM(100)	MM(100)	MM(100)
Aviation Ordnance	AGAO[c]	6500	105	GT(95), GM(95), EL(90)	GT(100), GM(100), EL(110)	GT(100)	GT(110)
Airborne Radio Operator	AGARO[d]	7381	110	GT(100)	GT(110)	GT(110)	GT(110)
Aviation Support Equipment, Electrical	AGASEL	6000		GT(85), GM(80)	GT(90), GM(100)	MM(100)	MM(100)
Aviation Support Equipment, Mechanical	AGASM	6000	95	GT(85), GM(80)	GT(85), GM(80)	MM(100)	MM(100)
Air Support Electronics Operator	AGASOPM	7242	100	GT(90)	GT(100)	GT(100)	GT(110)
Aviation Crash Crew	AGAVCC	7051	90	GM(80)	GM(80)	MM(90)	MM(90)
Aviation Maintenance Administration	AGAZ	6046	95	GT(85)	GT(90), CL(100)	CL(100)	CL(110)
Basic Electricity and Electronics	AGBEE[e]	6300	105	GT(100), EL(90)	GT(110), EL(110)	EL(110)	EL(110)
Basic Helicopter Maintenance	AGBHEL	6000	95	GT(85)	GT(100), GM(100)	MM(100)	MM(100)
Cryogenic Equipment Technician	AGCRYO	6075	100	GT(80), GM(90)	GT(90), GM(100)	MM(100)	MM(100)
HAWK Missile Fire Control Crewman	AGHFCRM[f]	7200	100	GT(90)	GT(100)	GT(100)	GT(110)

TABLE 27 (Cont'd)

Course Title	RDM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
HAWK Launcher and Mechanical Systems Repair	AGIHMSR	5929	100	GT(95), EL(100)	GT(95), EL(100)	EL(110)	EL(110)
Aircraft Launch and Recovery Equipment	AGMALRE	7011	90	GM(80)	GT(90), GM(95)	MM(90)	MM(100)
Marine Aviation Supply, Mechanized	AGMARAK	3072	95	GT(85)	GT(90), CL(100)	CL(100)	CL(110)
Aviation Operations Clerk	AGMAROC	7041	95	GT(85)	GT(90), CL(100)	CL(100)	CL(110)
Missile System Maintenance Fundamentals	AGMSMFC[g]	5900		GT(100), EL(110)	GT(100), EL(110), AR(11)	EL(110)	EL(110)
Aerial Navigator	AGNAV[h]	7371	110	GT(110), HS	GT(110), HS	GT(120), HS	GT(120), HS
Aircrew Survival Equipment	AGPR	6060	100	GT(90), GM(90)	GT(90), GM(100)	MM(100)	MM(100)
Turboprop Mechanic	AGPROP	6000		GT(85)	GT(90), GM(100)	MM(100)	MM(100)
REDEYE Gunner	AGRED	7212	90	FA(80)	GT(80), FA(80)	FA(90)	FA(90)
Ammunition Storage	AMMOT	2311	100	GT(90)	GT(90), AR(11)	GT(90)	GT(90)
Assault Amphibian Crewman	AMTRAC[i]	1833	90	FA(80)	FA(80)	FA(90)	FA(90)
Artillery Ballistic Meteorology	ARBALM[j]	0847	100	GT(90)	GT(90), FA(90)	FA(100)	FA(100)
Marine Artillery Scout Observer	ARSCOB	0861	90	FA(80)	GT(100), FA(90)	FA(90)	FA(100)
Aviation Support Equipment Technician (Electrical)	ASEGJ	6000		GM(80), GT(85)	GM(100), GT(90)	MM(100)	MM(100)
Audio/TV Production Specialist	AUDIOTV	4673		GT(90)	GT(90)	GT(110)	GT(110)
Basic Automotive Mechanic	AUTOMEC	3521	80	GT(90)	GT(90)	MM(90)	MM(100)

TABLE 27 (Cont'd)

Course Title	RSN Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Artillery Repair	ARMSMPR	2131	90	GM(80)	GM(90), GT(80), AR(11)	MM(90)	MM(100)
Administrative Clerk	BADE/BADW	0151	100	GT(90)	GT(100), CL(100)	CL(100)	CL(110)
Basic Baker	BAKER	3311	80	GT(90)	GT(100)	GT(90)	GT(100)
Basic Packing and Preservation Man	BASPACR	3052	80	CL(80)	CL(80)	CL(80)	CL(90)
Personnel Financial Records Clerk	BDC	3421	110	GT(110), CL(100), MS	GT(110), CL(110), MS	CL(110), MS	CL(100), MS
Basic Electronics	BEC/BCREC[k]	2800	110	GT(110), EL(100), MS	GT(110), EL(110), MS	EL(115), MS	EL(115), MS
Basic Electricity and Electronics	BEEG3[l]	5900/6300	105	GT(100), EL(90)	GT(110), EL(110)	EL(110)	EL(110)
Metal Body Repair	BODYMPR	3513	90	GM(80)	GM(90)	MM(90)	MM(100)
Technical Skills Bonus Program	BONUSAV[m]	6300		GT(100), EL(100)	GT(110), EL(110)	EL(110)	EL(120)
Basic Travel Clerk	BTRVCLR	3431		GT(100), CL(95)	GT(100), CL(100)	CL(100)	CL(110)
Fabric Repairman	CANMEB	1181	80	GM(80)	GM(80)	MM(80)	MM(90)
Basic Cartography	CARTO	1431	90	GT(80)	GT(90)	GT(90)	GT(100)
Basic Combat Engineer	CBTENG	1371	90	FA(80)	FA(80)	MM(90)	MM(90)
IBM System 360 OS, Cobol	COBOL	4063	110	GT(110), EDPT(61), MS	GT(110), EDPT(61), MS	GT(110), EDPT(61)[bb], MS	GT(110), EDPT(61), MS
Construction Drafting	CODRAFT	1411	95	GT(90)	GT(90), AR(11)	GT(100)	GT(110)
Communications Center Man	COMMCTR	2542	90	CL(90)	CL(95), MK(18)	CL(110)	CL(110)
Construcion Surveying	COMSURV	1441	95	GT(90)	GT(90)	GT(100)	GT(100)

TABLE 27 (Cont'd)

Course Title	BRM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Corrections Specialist	CORPSC	5831	90	GT(80)	GT(100), MM	GT(100)	GT(100), MM
Cryptographic Technician, O	CTECHO	2651	105	GT(95), CL(95)	GT(100), CL(100), MM	GT(100)	GT(110), MM
Cryptographic Technician, R	CTECHR	2621	110	GT(100), CL(95), MM	GT(100), CL(100), MM	GT(110), MM	GT(110), MM
Cryptographic Technician, T	CTECHT	2631		GT(100), CL(95), MM	GT(100), CL(100), MM	GT(110), MM	GT(110), MM
Defense Language Institute	DLI	2600	110	GT(100), ALAT(18), MM	GT(100), ALAT(18), MM	GT(110), ALAT(18)[cc], MM	GT(110), ALAT(18), MM
Basic Engineer Equipment Mechanic	EEMECH	1341	80	MM(80)	MM(90)	MM(90)	MM(100)
Engineering Equipment Operator	EEOPR	1345	90	GT(80), MM(80)	GT(80), MM(90)	MM(90)	MM(100)
Electrical Equipment Repairman	ELECTEP	1142	110	EL(100), GM(95), AR(11)	EL(120), GM(95), AR(11)	EL(100)	EL(100)
Basic Electrician	ELECTR	1141	100	EL(90)	EL(90), MM(18)	EL(90)	EL(100)
Basic Amphibious Embarkation Man	EMBARK[b]	0400	100	GT(80), CL(85), AR(11)	GT(90), CL(90), AR(11)	GT(100)	GT(100)
Financial Accounting Clerk	FAC	3451	100	GT(110), CL(100), MM	GT(110), CL(100), MM	GT(110), MM	GT(110), MM
Field Artillery Radar Crewman	FARAD	0842	100	FA(90)	FA(90)	FA(100)	FA(100)
Field Artillery Fire Control	FARTYFC[b]	0844	100	GT(90)	GT(90)	FA(110)	FA(110)
Fire Control Instrument Repair	FCINSPR	2171	100	GT(85), GM(90)	GT(85), GM(90), AR(11)	MM(100)	MM(100)
Basic Food Service Man	FOODSER	3371	80	GT(90)	GT(100)	GT(90)	GT(100)
Basic Lithographic Processes	FOTOLTH	1532	80	GT(80)	GT(90)	GT(80)	GT(90)

TABLE 27 (Cont'd)

Course title	RBM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Field Radio Operator	FRADIO	2531	90	GT(80)	GT(80), EL(90), WK(18)	EL(90)	EL(100)
Geodetic Surveying	GEOSURV	1442	95	GT(90)	GT(90), AR(11)	GT(100)	GT(100)
Graphics Specialist	GRAPHIC	4611		GT(90)	GT(90)	GT(100)	GT(100)
HAWK Launcher and Mechanical Systems Repair	HAWKMAJ	5929	100	EL(100), GT(99)	EL(100), GT(99)	EL(110)	EL(110)
Intelligence Specialist	INTELL	0231	90	GT(90)	GT(90)	GT(100)	GT(100)
Information Specialist (Broadcaster)	INFBCAD	4313	110	GT(110), CL(110), EE, WK(18)	GT(110), CL(110), EE, WK(18)	GT(110), EE	GT(110), EE
Information Specialist (Journalist)	INFJOURN	4321	110	GT(110), CL(110), EE, WK(18)	GT(110), CL(110), EE, WK(18)	GT(110), EE	GT(110), EE
Small Arms Repair	SMPNAIN	2111	90	GT(80)	GN(90), AR(11)	MM(90)	MM(100)
Laundry and Bath Specialist	LAUNDRY	1171	80	GN(80)	GN(80)	MM(80)	MM(90)
Legal Services Man	LEGEL[P]	4421	100	GT(100), CL(100)	GT(100), CL(100)	CL(100)	CL(110)
Marine Barracks	MBARRACK[Q]	0300	90	CO(80)	CO(80)	CO(90)	CO(90)
Basic Metal Worker	METWORK	1316	90	GN(80)	GN(90)	MM(90)	MM(100)
Military Police	MP	5811	90	GT(80)	GT(100), EE	GT(100)	GT(100), EE
Offset Duplicating/Printing	OFFSETD[R]	1521/1522	80	GT(80)	GT(90)	GT(80)	GT(90)
Office Machine Repair	OMACMPR	1182	90	GN(80), GT(80)	GN(90), GT(90)	MM(90)	MM(100)
IBM System 360 OS, Operations	OP360	4034	110	GT(110), EDPT(51), WK	GT(110), EDPT(51), WK	GT(110), EDPT(51), WK	GT(110), EDPT(51), WK

TABLE 27 (Cont'd)

Course Title	RDM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Continuous Photoprocessing Specialist	PHOTOSP	4671	90	GT(90)	GT(90)	GT(100)	GT(100)
Basic Plumbing and Water Supply Man	PLWASUP	1121	90	GM(80)	GM(90), AR(11)	MM(90)	MM(100)
Postal Operations	POSTAL	0161	95	GT(80), CL(85)	GT(90), CL(90)	CL(90)	CL(100)
Quartermaster Equipment Repair	QMMER	1173	90	MM(80)	MM(90)	MM(90)	MM(100)
Basic Refrigeration Mechanic	REFRIG	1161	100	GM(90)	GT(90), GM(90)	MM(100)	MM(100)
Machinist	RPRSHOP	2161	100	GM(90)	GM(90), AR(11)	MM(100)	MM(100)
Sea Duty	SEADU	0300	90	CO(80)	CO(80)	CO(90)	CO(90)
Shore Fire Control Party	SHOFCOP	0861	90	FA(80)	FA(90), GT(100)	FA(90)	FA(100)
Still Photographic Specialist	SPHOTO	4641	90	GT(100), CL(95), AR(11)	GT(100), CL(100), AR(11)	GT(100)	GT(110)
Subsistence Supply Man	SUSBIST	3061	90	GT(80), CL(80)	GT(100), CL(100)	CL(90)	CL(100)
Basic Supply Stock Control Man	SUPSTCH[a]	3043	100	GT(110), CL(110), AR(11), HS	GT(110), CL(110), AR(11), HS	CL(110), HS	CL(110), HS
Administrative Clerk	S 0151	0151	100	GT(90)	GT(100)	CL(100)	CL(110)
Infantry Training	S 0300/MB0300	0300	80	CO(80)	CO(80)	CO(80)	CO(90)
Logistics Operations Clerk	S 0441/S0441A	0441	90	CL(80)	CL(90), GT(90)	CL(90)	CL(100)
Field Artillery Batteryman	S 0811/MB0811[b]	0811	80	FA(80)	FA(80)	FA(90)	FA(90)
Combat Engineer	S 1371/MB1371	1371	80	GT(80)	GT(80)	MM(90)	MM(90)

TABLE 27 (Cont'd)

Course Title	RDM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Shore Party Specialist	S 1381/MB1381	1381	80	FA(80)	FA(80)	MM(80)	MM(90)
Bulk Fuel Specialist	S 1391/MB1391	1391	80	FA(80)	FA(80)	MM(80)	MM(90)
Amtrac Crewman	S 1833/MB1833	1833	90	FA(80)	FA(80)	FA(90)	FA(90)
Field Wireman	S 2512/MB2512	2512	90	EL(80)	EL(90)	EL(90)	EL(90)
Field Radio Operator	S 2531/MB2531	2531	90	GT(80)	GT(80), EL(90), WK(18)	EL(90)	EL(100)
Warehouse Clerk	S 3051/MB3051	3051	90	CL(80)	CL(90)	CL(90)	CL(100)
Purchasing and Contracting Specialist	S 3081	3081	110	CL(110), HS	CL(110), GT(100), HS	CL(110), HS	CL(110), HS
Freight Operations Clerk	S 3111	3111	80	CL(80)	CL(90)	CL(80)	CL(90)
Freight Transportation Clerk	S 3121	3121	80	CL(80)	CL(80)	CL(90)	CL(90)
Passenger Transportation Clerk	S 3141	3141	80	CL(80)	CL(80)	CL(90)	CL(90)
Baker	S 3311	3311	80	GT(90)	GT(100)	GT(90)	GT(100)
Cook	S 3371A[u]	3371	80	GT(90)	GT(100)	GT(90)	GT(100)
Heavy Vehicle Operator	S 3531A[v]	3531	80	MM(80)	MM(80)	MM(80)	MM(90)
Light Vehicle Operator	S 3535A[w]	3535	80	MM(80)	MM(80)	MM(80)	MM(90)
Marine Corps Exchange Man	S 4131	4131	90	CL(80), GT(80)	CL(90), GT(90)	CL(90)	CL(100)
Audiovisual Operations Specialist	S 4621	4621		CL(90)	CL(90)	CL(100)	CL(100)

TABLE 27 (Cont'd)

Course Title	RDM Assignment Symbol	MOS	Mandatory Prerequisites Level in 1975	Current Prerequisites for High School Graduates		Proposed Prerequisites for High School Graduates	
				Mandatory	Desirable	Mandatory	Desirable
Tank Crewman	TNKCRM[X]	1811	90	FA(80)	FA(80)	FA(90)	FA(90)
Assault Amphibian Repairman	TVRAMTR	2142	100	MM(90)	MM(90), AR(11)	MM(100)	MM(100)
Tracked Vehicle Repair, Artillery	TVRARTY	2144	100	MM(90)	MM(90), AR(11)	MM(100)	MM(100)
Tracked Vehicle Repair, Tank	TVRTANK	2145	100	MM(90)	MM (90),AR(11)	MM(100)	MM(10C)
Infantry Training	WESPACE[Y]	0300	80	CO(80)	CO(80)	CO(80)	CO(90)
Infantry Training	ITSWDA[Z]	0311	80	CO(80)	CO(80)	CO(80)	CO(90)

TABLE 27 (Cont'd)

[a]Prerequisites for non-high school graduates are 10 points higher.
[b]Also ACAGJ.
[c]Also AGAOGF.
[d]Also ARDGE, ARDGJ.
[e]Also AGBEEAB.
[f]Also MFCRMGE.
[g]Also MEMFCGE, MEMFCGJ.
[h]Also AMAVGF.
[i]Also AMTRCDA.
[j]Also AMBALDA.
[k]Also BBCGB, BECGE, BFCGJ.
[l]Also BEEASGJ, BEEABGB.
[m]Also BOMDSGE.
[n]Also EMBASKM.
[o]Also FARFCDA.
[p]Also LEGALGE.
[q]Also MBARAKM.
[r]Also OFFSETO.
[s]Also S 3043.
[t]Also S 08110A.
[u]Also S 3371F, S 3371M, MB3371F.
[v]Also S 3531F, S 3531M, MB3531F.
[w]Also S 3535F, S 3535M.
[x]Also TKCMMDA.
[y]Also MESPACM.
[z]Also ITSEDA.
[aa]Only high school diploma graduates for assignments denoted by HS.
[bb]The Electronic Data Processing Test (EDPT) is a special non-ASVAB test.
[cc]The Army Language Aptitude Test (ALAT) is a special non ASVAB test.

Because the military services have referenced all subsequent test scores, either directly or indirectly, back to the AGCT we may view scores on current versions of ASVAB as approximately equivalent to scores on the AGCT. For this reason it is of interest to compare the prerequisite levels we recommend with the test scores achieved by individuals in comparable civilian occupations during WWII. We show this comparison for a representative sample of courses in table 28. The comparison shows that the minimum test scores recommended by us agree rather well with those made by the 25th percentile of individuals in comparable civilian jobs during WWII.

TABLE 28

COMPARISON OF APTITUDE TEST LEVELS FOR COMPARABLE MILITARY AND CIVILIAN JOBS

Military		Civilian[a]	
Course	Mandatory prerequisite level	Comparable civilian job	Test score of 25th percentile of white WWII enlisted men from indicated civilian job
Basic electronics	115	*Radio repairman*	108
Basic supply stock clerk	110	Supply stock clerk	107
Administrative clerk	100	Clerk-typist	110
Machinists mate	100	Machinist	99
Military police	100	Policeman	96
Basic plumber	90	Plumber	87
Basic automotive mechanic	90	Automotive mechanic	89
Light truck driver	80	Light vehicle operator	80

[a]From [18].

We assume that the ability to perform a certain job has a strong bearing on whether an individual holds that job in the civilian economy. For this reason we view the generally similar test score levels shown for comparable military and civilian jobs as an external indication that our recommended prerequisites are reasonable.

CHAPTER 6

IMPROVED COMPOSITES FOR ASVAB 8/9/10

BACKGROUND

The ASVAB 8/9/10 composites discussed in chapter 4 represent interim solutions that, except for CL, are likely to have approximately the same validity as did the comparable ASVAB 6/7 composites used from 1 January 1976 through 30 September 1980. In this chapter we discuss possible improvements that might be made in future formulations of these composites. We also discuss an improved formulation of the AFQT.

In principle, the construction of improved composites should be very simple. One might conduct (as in table 6) a stepwise regression of individual ASVAB test scores against a performance criterion such as FCG. Having found the "best" set of test scores for predicting FCG in each course, one could simply use that combination as the composite for that course--right? Wrong!

If one proceeds in this fashion the result will generally be a different composite for each course (a minor inconvenience). Of more concern is that many of the composites will be "wrong." They will be wrong in the sense that they are not stable and, hence, not optimum. In our discussion of the global versus course-specific approach to composite selection (chapter 3) we set forth the reasons for this situation. Statistical uncertainties, residual range restriction uncertainties, and large test intercorrelations will produce unstable regression results that will lead to frequent and counter-productive changes in composite definitions. In this chapter we formulate composites by a method that minimizes these uncertainties.

Two important features of composite design are differentiation and validity. To some degree these two design criteria are related and it appears to be difficult to simultaneously achieve maximum differentiation and maximum validity. Reference [2] found that ASVAB 6/7 contains four common factors (math, verbal, shop, and attitude). Reference [3] found that it was possible to construct composites based on combinations of three of the pure factors (math, verbal, and shop) that would have validity as high as present composites but much better differentiation. Marine Corps testing personnel viewed the calculation of these composites as too complex for operational use. In this chapter we draw on the factor analysis approach, without the complication of calculating pure factors, to formulate a set of composites for ASVAB 8/9/10 that should combine high levels of differentiation with high levels of validity.

FACTOR ANALYSIS OF ASVAB 6/7

ASVAB 6/7 consists of 16 separate tests (table 1). Taken at face value, each of these tests measures a different attribute. In fact, many of these tests are highly correlated and may really measure the same or very similar attributes. To reduce the apparent complexity of the separate tests and gain some insight into the attributes actually measured by the battery we conducted a standard factor analysis. The details of the analysis are given in appendix H.

The tests in the battery are assumed to consist of factors shared by that test and one or more other tests (common factors) and a factor unique to that test (specific factor). The contribution of the factors is frequently described in terms of the percentage of the variance in scores of each test that is due to each common factor, that which is unique to each test (specificity), and that due to measurement error.

The analysis described in appendix H found that ASVAB 6/7 could be described in terms of four common factors, which we denote as "verbal," "math," "shop," and "attitude." The factor content of the individual tests is illustrated in figure 6. It is seen that WK, GS, and GI are dominated by the verbal factor. These tests also display some specificity and, of course, measurement error. The AR and MK tests contain significant amounts of the math factor as well as the verbal factor. The only common factor in the NO test is the math factor. The AI, SI, EI, and MC each contain shop and verbal factors. The remaining tests were not included in ASVAB 8/9/10 and, hence, are not of concern in this discussion. A knowledge of the factor content of the tests gives us a basis for grouping the tests into three types: those that are primarily verbal, those that contain significant amounts of math, and those that contain significant amounts of shop. By grouping the tests in this manner we can analyze group behavior and thereby lessen the effects of the uncertainty in the regression approach to constructing better composites.

FORMULATION OF EXPERIMENTAL ASVAB 8/9/10 COMPOSITES

We use validity data from all 33 FCG courses with 100 or more cases. The first step in our procedure is stepwise regression* of performance (FCG) as a function of those ASVAB 6/7 tests that were retained in ASVAB 8/9/10. The results for the best combinations of three tests are tabulated in table 29. For example, the three most important tests for predicting success in the Basic Supply Stock Clerk course were MK, WK, and AR. Together they had a multiple correlation with FCG of 0.60. Groups of three were chosen because the multiple

* Only variables entering the regression with a positive sign and having a significance level of at least 0.05 were allowed.

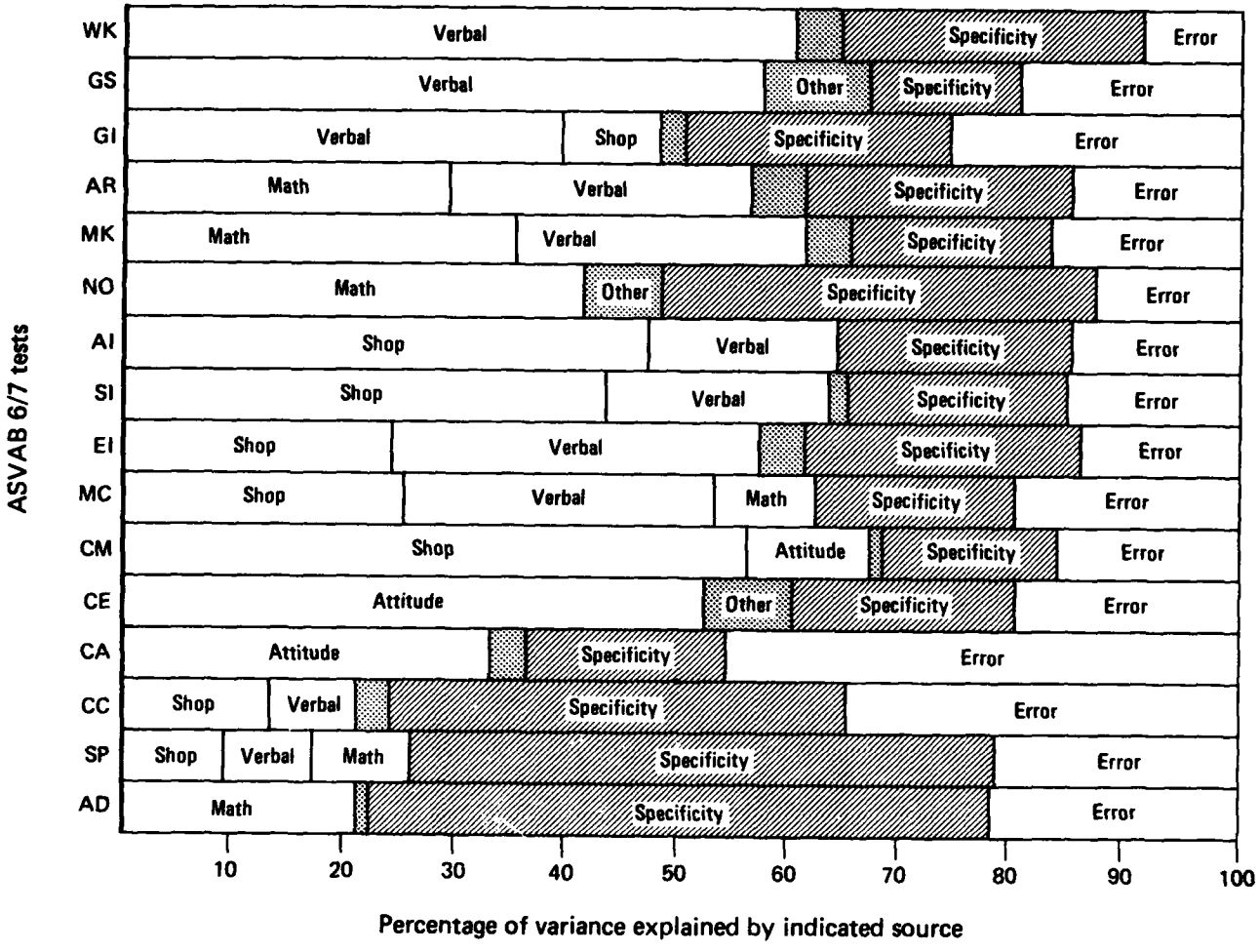


FIG. 6: FACTOR CONTENT OF INDIVIDUAL ASVAB 6/7 TESTS

TABLE 29

BEST COMBINATION OF ASVAB TESTS[a] FOR PREDICTING SUCCESS IN TRAINING

Course	Best combination[b] of tests	Multiple correlation[c] for indicated number of tests			
		1	2	3	4
Basic supply stock clerk	MK, WK, AR	56	59	60	60
Personal financial records clerk	MK, AR, NO	62	67	68	68
Basic automotive mechanic	AI, MK, EI	61	68	71	72
Advanced automotive mechanic	MC, AI, AR	63	69	73	74
Basic baker	MK, EI, AR	55	60	62	62
Basic food service	GS, AR, MK	47	53	54	55
Basic combat engineer	MC, AR, EI	57	64	67	68
Basic electrician	MC, WK, AI	44	49	51	54
Electrical equipment repairman	MK, WK	38	41	41	41
Basic engineer equipment mechanic	MC, AI, MK	53	60	64	64
Administrative clerk	MK, WK, NO	54	59	60	62
Personnel clerk	MK, NO, WK	58	61	63	65
Unit diary clerk	MK, WK	59	64	64	64
Sea duty indoctrination	WK, NO, GS	46	52	55	56
Basic electronics	MK, EI, GS	60	65	66	67
Radio fundamentals	GS, NO, SI	40	45	47	48
Field radio operator	MK, EI, WK	48	53	55	55
Communications center man	MK, WK, NO	54	60	63	64
Infantry training	GS, MK, MC	30	33	34	35
Tracked vehicle repair	GS, AR, WK	60	67	68	70
Basic helicopter	MC, MK, AI	51	58	63	64
Aviation structural mechanic (safety equipment)	MK, EI, WK	50	58	60	61
Aviation structural mechanic (hydraulics)	MC, GS, AR	58	64	66	68
Aviation structural mechanic (structural)	GS, MK, SI	55	61	63	64
Aviation ordnance	MK, MC, GS	53	59	61	61
Aviation crash crew	AR, EI, AI	41	48	49	49
Avionics repair	AR, EI, MC	57	67	69	70
Aviation operations (clerical)	MK, AR, NO	46	48	50	50
Aviation maintenance administration	MK, AR, GS	56	59	60	61
Aviation supply (mechanical)	MK, WK, NO	58	61	63	64
Small arms repair	MC, AR, SI	38	43	46	48
Ammunition storage	GS, MK, SI	55	60	63	64
Basic cannoneer	MK, GS	49	55	55	55
Mean		52	57	59	60

[a] Of those ASVAB 6/7 tests that were retained in ASVAB 8/9/10.
[b] In order entered into stepwise regression. Only variables with positive signs and at least 0.05 significance level were allowed.
[c] Multiplied by 100 and corrected for restriction of range. Some regressions terminated before four tests entered. In these cases the multiple correlation from the terminal step was assumed to hold for all remaining steps.

correlation generally did not increase significantly with the addition of more tests.

The results of table 29 are grouped by test type and course type in table 30. The test type groupings were determined by the factor analysis discussed earlier. For example, for six courses in the mechanical grouping the MC test was one of the three most important predictors of FCG. Because many of the tests are strongly correlated we cannot, for example, take at face value that six mechanical courses should use MC as a predictor, five should use AI, two should use SI, and four should use EI. We can, however, be confident that if MC enters the stepwise regression then some shop-type test is needed as a predictor for that course. In table 31 we show the same data with entries for tests of similar content further collapsed into broad test-type categories. We see that different test types are important for the mechanical, electrical, and clerical course groupings. The data for the three remaining course groupings is so sparse that they probably cannot be treated separately.

Mechanical courses in table 31 are seen to require heavy concentrations of tests with dominant shop and math factors. The electrical courses seem to require more balance and need tests of verbal, math, and shop content. Clerical courses need heavy concentrations of math and some verbal content. Taken as a whole, the three remaining course groupings (field artillery, combat, and general) require approximately equal amounts of math and verbal content. These three course groupings may be reasonably described as "general."

Summing over all course groupings we get an approximation to the overall requirements for success in military training. The overall requirement seems to be about two parts math, one part verbal, and one part shop. This requirement should define the AFQT.

In table 32 we show our proposal for meeting the requirements summarized in table 31. Our system would consist of four aptitude area composites (MM, EL, CL, and GT) plus an AFQT to measure general trainability. The tests we selected for each composite were chosen based on common factor content, presumed unique test content, and the avoidance of unnecessarily high composite intercorrelations.

In our view the aptitude composite and AFQT system proposed in table 32 offers improved differentiation, better balance, and equal or better validity than the present system. Particular improvement is likely to be seen in the CL composite because the available evidence suggests that the present CL is deficient in math content. The redefinition of the AFQT to include a shop component (MC) is clearly reasonable given its role as a measure of general trainability. This redefinition follows the tradition of a shop component in previous versions of AFQT and in service-specific test instruments such as the Navy Basic Test Battery (BTB).

TABLE 30

MOST IMPORTANT TESTS IN ASVAB 6/7 BY COURSE GROUPING

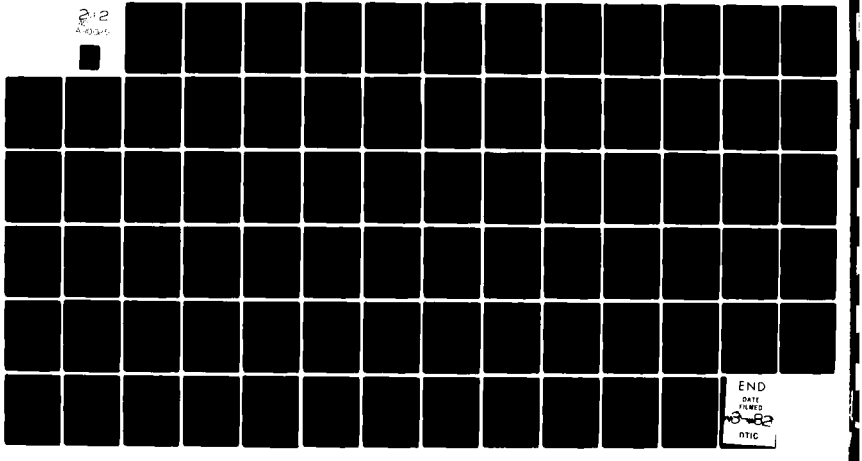
		Number of courses for which indicated test was one of three most important predictors by course grouping						
Test type	Test	Mechanical	Electrical	Clerical	Artillery	Combat	General	Total
Verbal	WK	2	3	6	0	1	0	12
	GS	3	2	1	1	2	3	12
Math	MK	5	3	9	1	1	4	23
	AR	6	1	4	0	0	2	13
	NO	0	1	6	0	1	0	8
Shop	MC	6	2	0	0	1	1	10
	AI	5	1	0	0	0	0	6
	SI	2	1	0	0	0	1	4
	EI	4	3	0	0	0	1	8

TABLE 31

MOST IMPORTANT TEST TYPE IN ASVAB 6/7 BY COURSE GROUPING

	Number of courses for which indicated test type was one of the three most important predictors by course grouping						
Test type	Mechanical	Electrical	Clerical	Artillery	Combat	General	Total
Verbal	5	5	7	1	3	3	24
Math	11	5	19	1	2	6	44
Shop	17	7	0	0	1	3	28

AD-A110 025 CENTER FOR NAVAL ANALYSES ALEXANDRIA VA MARINE CORP--ETC F/G 5/9
VALIDATION OF THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (A--ETC(U)
FEB 81 W H SIMS, C M HIATT N00014-76-C-0746
UNCLASSIFIED CNS-1160 NL



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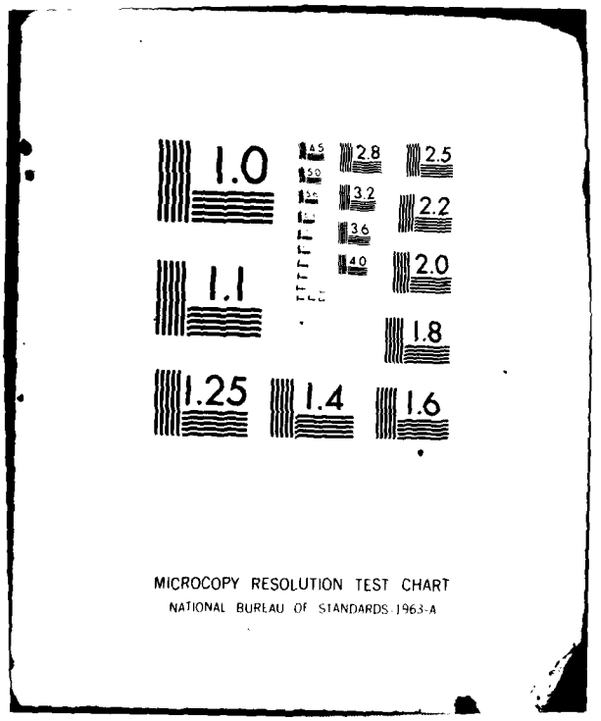
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 32

CONTENT OF EXPERIMENTAL ASVAB 8/9/10 COMPOSITES

	Course grouping (selector composite)				
Test type	Mechanical (MM)[a]	Electrical (EL)[b]	Clerical (CL)[c]	General (GT)[d]	Total (AFQT)[e]
Verbal		GS	VE	VE	VE
Math	AR	MK	MK NO	AR	AR NO
Shop	MC AS	EI			MC
Miscellaneous			CS		

[a] MM = AR + MC + AS .
[b] EL = GS + MK + EI .
[c] CL = VE + MK + NO + CS .
[d] GT = VE + AR .
[e] AFQT = VE + AR + NO + MC .

We view the set of composites shown in table 32 as experimental composites. We have a high degree of confidence in the use of the MM, EL, and CL in this table for mechanical, electrical, and clerical courses, respectively. We are also confident of our formulation of AFQT. Our uncertainty, and the reason for referring to these composites as experimental, lies in the use of the GT for courses such as infantry training and tank crew, which by default must fall in the general category. Currently available criterion measures for these courses are marginal; hence, we recommend examination of additional validity data--including job performance measures, before a decision is made on the use of the complete set of composites in table 32.

EVALUATION OF EXPERIMENTAL COMPOSITES

It is possible to evaluate some aspects of some of the experimental composites using existing data to simulate* the composites.

* The experimental composites were simulated from ASVAB 6/7 data as:
MM = AR + MC + (AI + SI)/2
EL = GS + MK + EI
CL = WK + MK + NO
GT = WK + AR .

The intercorrelations of the experimental ASVAB 8/9/10 composites (table 33) are seen to be smaller than those for the interim ASVAB 8/9/10 composites (table 34).

TABLE 33

INTERCORRELATIONS[a,b,c] OF EXPERIMENTAL ASVAB 8/9/10 COMPOSITES

	MM	EL	CL	GT
MM	--	89	80	90
EL	89	--	86	91
CL	80	86	--	89
GT	90	91	89	--

[a]From a stratified sample of 2,025 applicants from all services.
[b]Mean intercorrelation of 87.5.
[c]All coefficients are multiplied by 100.

TABLE 34

INTERCORRELATION[a,b,c] MATRIX FOR INTERIM ASVAB 8/9/10 COMPOSITES

	MM	EL	CL	GT	FA	CO	GM
MM	--	94	76	90	96	90	96
EL	94	--	81	94	94	88	97
CL	76	81	--	85	82	91	78
GT	90	94	85	--	97	91	90
FA	96	94	82	97	--	95	95
CO	90	88	91	91	95	--	91
GM	96	97	78	90	95	91	--

[a]Correlation coefficients were computed from a stratified sample of 2,025 applicants for enlistment from all services.
[b]Mean intercorrelation is 90.0.
[c]All coefficients are multiplied by 100.

The validity of the experimental ASVAB 8/9/10 composites can be estimated using the simulation procedure. The resulting validity coefficients are shown in table 35. The mean validity of the experimental composites is higher than that of either the ASVAB 6/7 composites or the interim ASVAB 8/9/10 composites. Particular improvement is seen in the

validity of the experimental CL composite. We believe this improvement is sufficiently large that we recommend adopting the experimental CL composite for operational use as soon as possible.

TABLE 35

COMPARISON[a] OF VALIDITIES FROM VARIOUS COMPOSITE FORMULATIONS

Course	Composite	ASVAB 6/7	Simulated[b] interim ASVAB 8/9/10	Simulated experimental ASVAB 8/9/10
Basic automotive mechanic	MM	0.65	0.71	0.69[c]
Basic electronics	EL	0.61	0.61	0.65[d]
Administrative clerk	CL	0.53	0.49	0.58[e]
Mean		0.60	0.60	0.64

[a]Corrected for restriction of range.
[b]Interim composites simulated as in table 22.
[c]Experimental MM composite simulated as AR+MC+(AI+SI)/2.
[d]Experimental EL composite simulated as GS+MK+EI.
[e]Experimental CL composite simulated as WK+MK+NO.

Our design goal of improved differentiation and improved validity seems to have been met by the experimental composites. Further analysis will determine if the complete set of four is sufficient for all types of courses.

REFERENCES

[1] CNA, Memorandum 78-3081, "Interim Results of an Examination of the Armed Services Vocational Aptitude Battery (ASVAB) Forms 6 and 7 for the Classification of Marine Corps Recruits," by William H. Sims, Unclassified, 31 Jul 1978

[2] CNA, Memorandum 78-3092, "A Factor Analysis of the Armed Services Vocational Aptitude Battery (ASVAB) Forms 6 and 7," by William H. Sims and Thomas L. Mifflin, Unclassified, 28 Aug 1978

[3] CNA, Memorandum 78-3094, "An Application of Factor Analyses to the Construction of Improved Classification Composites from the Armed Services Vocational Aptitude Battery (ASVAB) Forms 6 and 7," by William H. Sims, Unclassified, 15 Sep 1978

[4] Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics), "Aptitude Testing of Recruits," Unclassified, Jul 1980

[5] ASVAB Working Group, "Conversion Tables for ASVAB 6/7," Unclassified, 11 Jul 1980

[6] CNA, Study 1152, "A Reexamination of the Normalization of the Armed Services Vocational Aptitude Battery (ASVAB) Forms 6, 7, 6E, and 7E," by William H. Sims and Ann R. Truss, Unclassified, Apr 1980

[7] CNA, Research Contribution 336, "A Method to Correct Correlation Coefficients for the Effects of Multiple Curtailment," by Thomas L. Mifflin and Steven M. Verna, Unclassified, Aug 1977

[8] Burt, Cyril. "Validating Tests for Personnel Selection." British Journal of Psychology 34 (1943): 1-19

[9] Alexander, Clifford, Secretary of the Army, as quoted in Newsweek, p. 52, 27 Oct 1980

[10] CNA, Memorandum 80-3092, "Converting Operational ASVAB 6/7 Scores to Correctly Normalized Scores," by Catherine M. Hiatt and William H. Sims, Unclassified, 25 Nov 1980

[11] CNA, Study 1084, "An Analysis of Marine Corps School Assignment and Performance," by Steve Verna and Thomas L. Mifflin, Unclassified, Jan 1977

[12] CNA, Research Contribution 438, "Normalization of the Armed Services Vocational Aptitude Battery (ASVAB) Forms 8, 9, and 10 Using a Sample of Service Recruits," by William H. Sims and Ann R. Truss, Unclassified, Dec 1980

[13] Army Research Institute, Research Report 1308, "Scaling Armed Services Vocational Aptitude Battery (ASVAB) Form 8AX, by Milton H. Maier and Frances C. Grafton, Unclassified, forthcoming

[14] Headquarters, United States Marine Corps, "Automated Schools Report-FY 1980," Unclassified, No date

[15] Headquarters, United States Marine Corps, "Recruit Assignment Dictionary of Job Prerequisites," Unclassified, Jun 1975

[16] Headquarters, United States Marine Corps, MCO P1500.12L, "Marine Corps Formal Schools Catalog," Unclassified, Apr 1980

[17] Headquarters, United States Marine Corps, MCO P1200.7D, "Military Occupational Specialties Manual," Unclassified, Dec 1979

[18] Stewart, Naomi. "AGCT Scores of Army Personnel Grouped by Occupation." Occupations, The Vocational Guidance Journal (October 1947)

APPENDIX A

STUDY DOCUMENTATION

APPENDIX A

STUDY DOCUMENTATION

This appendix contains the documents received concerning this study effort. The study request is presented first. The data collection and reporting procedures are shown in annex A-1.

NAVMC 5216/144 (REV. 8-76)
S/N 0107-LF-776-5099

DEPARTMENT OF THE NAVY

Memorandum

MPI-28:mml
5400/1
DATE 17 JAN 1977

FROM: Deputy Chief of Staff for Manpower

TO: Deputy Chief of Staff for Research, Development and Studies

SUBJ: Armed Services Vocational Aptitude Battery (ASVAB) Test Validation; request for support of Marine Corps Operations Analysis Group

Ref: (a) MCO 5400.7B

1. In accordance with reference (a), it is requested that a validation study be conducted with the Armed Services Vocational Aptitude Battery (ASVAB).

2. The objectives of the ASVAB validation for service school selection are:

a. Determination of best aptitude area composite for predicting service school completion.

b. Determination of best combination of subtests for prediction of service school composite.

c. Determination of the interrelationship of education and aptitude area composites on service school completion.

d. Determination of service school prerequisites which optimize qualified personnel available and service school completion.

3. Informal liaison with Marine Corps Operations Analysis Group (MCOAG) representatives has been conducted concerning the objective of the subject analysis and an understanding of these objectives has been reached. Accordingly, it is requested that the Deputy Chief of Staff for Research, Development and Studies task the MCOAG to conduct a validation study of ASVAB. Marine Corps point of contact is Mr. S. GORMAN, GS-11, Code MPI-20, telephone 694-4165.

[illegible]
By direction

ANNEX A-1

DATA COLLECTION INSTRUCTIONS

INSTRUCTIONS FOR COMPLETING AND FORWARDING U. S. MARINE CORPS SCHOOL DATA FORM

1. The U. S. Marine Corps School Data Form will be used to evaluate the effectiveness of the Armed Services Vocational Aptitude Battery (ASVAB) in classifying Marines for basic entry level training. The forms, which are in optical scannable format, must be completed for every student entering a course, whether he/she graduates or is disenrolled for any reason.

2. Forms should be completed for all Marines who began training after 1 March 1977 at any of the courses listed in enclosure (1).

3. The following specific directions should be followed for completion of the Marine Corps School Data Form:

a. Columns 1-14. Fill out for all students.

(1) Columns 1-2, COURSE NUMBER. Use the appropriate course codes from enclosure (1).

(2) Columns 3-11, SOCIAL SECURITY NUMBER. Darken the appropriate columns with social security number or military identification number (MID).

(3) Column 12, PASS/FAIL. Darken "1" if Marine passed the course; darken "0" if Marine did not pass the course.

(4) Columns 13-14, FINAL COURSE GRADE. Darken appropriate columns with final course grade in the range 00 through 99. (Code final course grade 100 as 99.)

b. Columns 15-26 are to be filled out only for self-paced courses.

(1) FIRST DAY OF CLASS. Use the first day of actual self-paced instruction.

(a) Columns 15-16, DAY. Darken the day (range 01 to 31) of the first day of class.

(b) Columns 17-18, MONTH. Darken the month that the self-paced instruction began (range 01 to 12).

(c) Columns 19-20, YEAR. Darken the year of instruction (range 77 to 80).

ENCLOSURE (3)
Ch 1 (27 Feb 1978)

(2) LAST DAY OF CLASS. Use the date that the Marine last attended instruction.

(a) Columns 21-22, DAY. Use the last day of actual instruction (range 01 to 31).

(b) Columns 23-24, MONTH. Darken the month instruction ended (range 01 to 12).

(c) Columns 25-26, YEAR. Darken the year instruction ended (range 77 to 80).

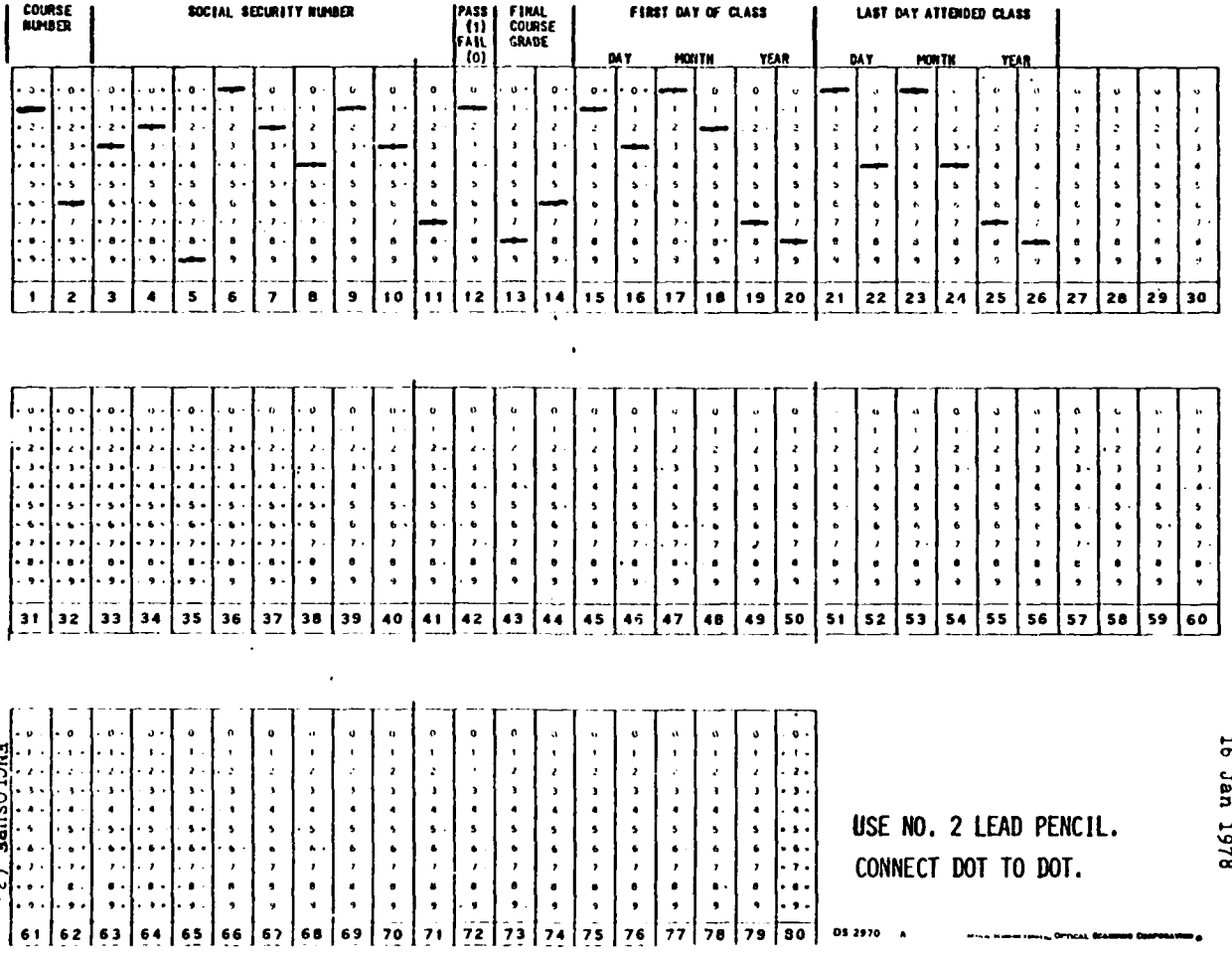
4. Complete the forms using a No. 2 lead pencil to darken the appropriate entry horizontally from dot to dot as indicated in the sample on page 3 of this enclosure.

5. After course completion, mail completed forms to the below address. Include forms for any Marines disenrolled for any reason.

MCOAG Study Director
ASVAB Validation Study
Center for Naval Analyses
1401 Wilson Boulevard
Arlington, Virginia 22209

6. Queries concerning completion of the study may be directed to Dr. William SIMS, MCOAG, Arlington, Virginia, AUTOVON 225-9241, commercial (703) 524-9400 or Major Harold D. HOCKADAY, Commandant of the Marine Corps (Code MPI-20), AUTOVON 224-4165, commercial (703) 694-4165.

MARINE CORPS SCHOOLS DATA FORM



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ENCLOSURE (3)
CH 1 (27 Feb 1978

APPENDIX B

DEFINITIONS OF ASVAB 6/7 TESTS AND COMPOSITES

APPENDIX B

DEFINITIONS OF ASVAB 6/7 TESTS AND COMPOSITES

The individual ASVAB 6/7 tests are given in table B-1. Composites used by the Army and Marine Corps are shown in table B-2. These composites are defined by the formulas given in table B-3. Composites used by the Navy and Air Force are defined by the formulas given in table B-4.

TABLE B-1

INDIVIDUAL ASVAB 6/7 TESTS

GI = General Information

NO = Numerical Operations

AD = Attention to Detail

WK = Word Knowledge

AR = Arithmetic Reasoning

SP = Spacial Perception

MK = Mathematics Knowledge

EI = Electronic Information

MC = Mechanical Comprehension

GS[a] = General Science

SI = Shop Information

AI = Automotive Information

CC = Combat Scale

CA = Attentiveness Scale

CE = Electronics Scale

CM = Maintenance Scale

---

[a]Note that the full-length GS test, rather than the short GSB test, is used throughout this report.

TABLE B-2

MARINE CORPS AND ARMY ASVAB 6/7 COMPOSITES

CO = Combat

FA = Field Artillery

OF = Operators and Food Handlers

MM = Mechanical Maintenance

GM = General Maintenance

CL = Clerical

GT = General Technical

EL = Electronics

SC = Surveillance and Communications

ST = Skilled Technical

GCT = General Classification Test

TABLE B-3

FORMULAS FOR COMPUTING MARINE CORPS AND ARMY ASVAB 6/7 COMPOSITES

CO	=	AR + SI + SP + AD + CC
FA	=	AR + GI + MK + EI + CA
MM	=	MK + SI + EI + AI + CM
GM[a]	=	AR + GS + MC + AI
CL	=	AR + WK + AD + CA
GT	=	AR + WK
EL[a,b]	=	AR + GS + MK + EI
EL[a,c]	=	AR + EI + MC + SI + CE
SC	=	AR + WK + MC + SP
ST[a]	=	AR + MK + GS
OF	=	GI + AI + CA
GCT	=	AR + WK + SP

[a]GS rather than GSB is used throughout this report.
[b]Marine Corps only.
[c]Army only.

TABLE B-4

FORMULAS FOR COMPUTING NAVY AND AIR FORCE
ASVAB 6/7 COMPOSITES

Navy

G = WK + AR

M = WK + MC + SI

E = AR + MK + EI + GS

C = NO + AD + WK

Air Force

M = MC + SI + AI

A = NO + AD + WK

G = WK + AR

E = AR + SP + EI

APPENDIX C

UNCORRECTED CORRELATION COEFFICIENTS

APPENDIX C

UNCORRECTED CORRELATION COEFFICIENTS

Uncorrected validity coefficients for individual ASVAB tests and composites are shown in tables C-1 and C-2, respectively. Uncorrected means and standard deviations of the criterion variable (FCG) are shown in table C-3.

TABLE C-1

UNCORRECTED VALIDITY COEFFICIENTS[a] FOR INDIVIDUAL ASVAB TESTS

Course	GI	NO	AD	WK	AR	SP	MK	EI	MC	GS	SI	AI	CM	CA	CE	CC
Basic supply stock clerk	21	22	05	31	38	17	49	27	21	33	10	15	-10	17	08	02
Personal financial records clerk	14	40	21	14	51	28	53	19	25	31	11	22	00	20	09	13
Basic automotive mechanic	39	16	04	32	47	20	34	48	47	39	49	52	22	-03	03	21
Advanced automotive mechanic	35	15	05	26	36	26	[illegible]	4	46	43	38	45	14	00	08	10
Basic baker	27	28	12	07	36	16	4[illegible]	3[illegible]	35	36	26	30	07	00	04	12
Basic food service	30	29	07	19	38	26	[illegible]	39	35	41	36	31	05	03	-07	26
Basic combat engineer	39	24	05	40	49	34	[illegible]	43	52	49	49	45	14	-14	-04	30
Basic electrician	22	09	-11	36	27	05	25	25	33	25	31	35	20	01	15	16
Electrical equipment repairman	31	10	-05	23	19	19	27	1[illegible]	23	2[illegible]	19	15	05	01	15	14
Basic engineer equipment mechanic	33	25	12	30	35	20	30	32	40	3[illegible]	36	40	18	04	08	22
Administrative clerk	13	39	22	36	43	21	49	28	27	39	10	14	-09	21	01	13
Personnel clerk	19	42	15	35	42	20	50	28	19	26	12	17	07	21	13	14
Unit diary clerk	11	25	03	35	31	18	53	16	21	30	01	04	-12	21	04	06
Sea duty indoctrination	28	27	09	30	15	07	28	21	20	31	22	13	-02	10	07	12
Basic electronics	22	27	18	23	38	26	45	33	34	37	19	22	10	10	35	09
Radio fundamentals	04	18	04	15	10	19	18	16	12	23	15	17	08	-02	09	04
Field radio operator	21	20	11	33	33	18	38	27	29	33	18	23	05	05	14	12
Communications center man	32	38	-03	38	46	20	48	23	28	40	12	15	-12	14	11	05
Air control electronic operator	18	11	-05	08	31	15	27	37	23	21	11	06	00	14	22	11
Infantry training	23	19	10	19	20	17	24	22	24	26	20	19	05	07	05	17
Tracked vehicle repair	34	16	07	43	39	23	35	35	36	48	21	26	-02	03	08	10
Basic helicopter	31	18	04	33	29	17	37	34	37	35	32	36	11	-0[illegible]	08	13
Aviation structural mechanic (safety equipment)	22	16	14	29	30	14	34	39	30	26	18	17	14	01	16	23
Aviation structural mechanic (hydraulics)	25	07	03	25	26	19	25	29	36	33	30	25	12	-07	01	16
Aviation structural mechanic (structures)	20	19	15	26	20	19	33	23	30	35	26	22	08	07	08	10
Aviation ordnance	21	15	08	14	25	19	35	22	30	25	15	20	02	-03	09	02
Aviation crash crew	32	16	02	26	32	16	28	34	30	20	28	29	12	-02	00	23
Avionics repairman	14	10	05	15	28	08	17	29	31	26	17	23	13	-01	13	11
Air controlman	11	20	05	26	50	12	41	16	37	35	-08	14	-07	-02	05	06
Air control maintenance	10	-12	14	13	27	01	-06	-08	06	09	07	09	10	36	03	04
Aircraft launch and recovery	29	24	14	23	38	16	33	36	35	31	31	34	15	-07	12	20
Air crew survival equipment	05	14	18	21	-04	06	11	-02	10	06	-06	-06	-24	-02	-03	06
Marine aviation operations (clerical)	03	32	27	19	33	34	40	14	20	18	-04	-03	-10	07	01	07
Aviation maintenance administration	01	28	12	27	41	18	46	22	17	30	13	08	-16	13	07	-01
Marine aviation supply (mechanical)	26	36	22	28	37	20	46	24	20	32	13	17	-01	11	07	10
Aerographers mate	21	07	39	15	-01	50	10	29	17	30	40	36	22	-02	14	-02
Small arms repair	23	21	24	30	37	43	35	37	37	28	35	33	20	07	11	29
Tank crewman	12	10	06	07	03	14	-01	17	07	06	17	13	10	11	04	08
Field artillery fire control	33	18	24	45	53	29	45	21	38	37	25	25	01	23	04	29
Ammunition storage	34	15	09	30	23	16	31	28	14	36	27	19	07	09	14	10
Corrections specialist	18	17	11	04	17	11	22	21	10	08	14	15	07	07	03	12
Military police	28	24	12	23	24	17	30	31	27	33	30	23	02	04	02	21
Basic cannoneer	22	29	10	31	37	24	42	22	33	43	31	30	09	02	08	27
Basic electricity & electronics	09	15	08	12	25	12	32	16	17	17	05	10	02	08	23	04
Aviation machinists mate	13	22	16	18	31	17	24	22	20	18	17	13	07	03	09	12
Avionics technician	14	12	-01	12	10	01	15	12	-04	07	07	11	-02	01	05	10

[a]Multiplied by 100.

TABLE C-2

UNCORRECTED VALIDITY COEFFICIENTS[a] FOR ALL SERVICE ASVAB COMPOSITES

Course	Marine Corps/Army												Air Force				Navy			
	CO	FA	EL[b]	OF	GM	MM	CL	ST	GT	SC	GCT[b]	EL[c]	M	A	G	E	M	C	G	E
Basic supply stock clerk	23	49	49	27	35	26	39	51	42	39	41	30	18	28	39	34	27	27	44	49
Personal financial records clerk	41	49	50	29	41	29	45	55	41	44	45	30	23	38	40	41	24	37	47	51
Basic automotive mechanic	44	51	55	49	61	61	32	47	42	49	42	56	59	26	42	50	55	23	43	55
Advanced automotive mechanic	38	48	52	46	61	55	30	46	41	51	44	53	54	22	40	47	51	20	43	52
Basic baker	33	51	54	33	46	40	27	51	27	35	28	43	34	29	28	43	33	25	30	53
Basic food service	44	47	50	34	47	40	29	49	33	39	37	42	38	30	32	46	39	25	37	52
Basic combat engineer	52	54	59	40	61	53	38	56	49	56	52	56	56	35	50	55	57	31	51	60
Basic electrician	22	37	39	32	42	40	26	33	36	37	32	42	37	19	36	27	42	13	37	40
Electrical equipment repairman	20	33	27	25	24	24	17	24	28	28	26	27	19	15	21	15	27	11	27	27
Basic engineer equipment mechanic	40	43	44	41	50	48	33	41	37	44	39	46	46	33	37	40	45	30	38	44
Administrative clerk	36	49	51	26	41	27	50	53	47	45	46	32	20	46	45	42	31	44	48	52
Personnel clerk	31	48	45	27	33	30	46	46	45	41	44	31	18	45	44	37	26	38	45	45
Unit diary clerk	20	44	44	19	29	18	40	50	42	37	39	21	11	32	39	29	23	27	40	46
Sea duty indoctrination	24	33	33	24	25	22	30	32	31	28	27	26	21	35	31	20	30	29	30	35
Basic electronics	38	51	53	29	44	37	36	52	38	43	41	46	28	32	33	41	35	32	40	54
Radio fundamentals	19	21	29	12	21	21	12	22	18	22	22	20	17	14	13	22	19	16	17	28
Field radio operator	31	42	44	26	40	33	34	43	39	40	39	36	27	29	38	36	35	28	39	45
Air control electronic operator	26	49	48	30	42	24	45	53	49	46	48	33	21	41	48	37	33	32	51	50
Communications center man	22	45	44	17	29	24	17	35	26	27	23	38	16	15	22	39	15	-02	18	40
Infantry training	27	29	30	24	29	20	24	29	23	27	25	27	25	23	22	26	27	22	23	30
Tracked vehicle repair	35	46	51	32	55	39	41	49	48	53	43	44	35	32	49	44	44	26	47	52
Basic helicopter	31	44	47	36	49	44	29	43	38	42	38	43	42	25	38	36	45	23	38	48
Aviation structural mechanic (safety equipment)	34	43	43	22	36	39	32	38	38	40	38	40	25	27	33	39	35	27	37	45
Aviation structural mechanic (hydraulics)	33	37	42	24	46	39	24	39	34	42	37	41	37	16	34	36	43	14	34	44
Aviation structural mechanic (structures)	35	39	26	39	33	31	38	29	37	33	33	30	29	29	30	29	39	28	30	41
Aviation ordnance	24	36	40	21	36	28	19	40	25	33	30	32	27	19	24	31	28	17	27	40
Aviation crash crew	34	40	40	32	39	38	27	36	34	37	28	38	34	23	34	38	35	18	35	38
Avionics repairman	24	34	41	21	38	31	21	35	26	32	26	39	30	15	27	31	32	14	28	41
Air controlman	19	38	44	13	27	13	27	54	45	47	40	26	14	23	43	30	22	19	47	48
Air control maintenance	20	17	05	26	17	02	34	13	26	18	21	08	13	02	24	05	10	07	30	08
Aircraft launch and recovery	40	42	44	32	48	47	30	38	34	37	34	42	42	31	32	43	40	27	38	45
Air crew survival equipment	08	04	04	-02	03	-08	16	06	11	11	10	-04	-03	24	14	-01	10	25	08	04
Marine aviation operations (clerical)	36	34	37	02	25	10	35	40	30	40	35	19	04	36	31	35	14	34	28	36
Aviation maintenance administration	29	42	46	12	32	19	38	48	43	40	43	28	14	30	38	38	28	32	45	48
Marine aviation supply (mechanical)	36	47	46	28	37	28	43	48	40	40	41	31	19	41	40	37	28	40	41	47
Aerographers mate	46	27	35	33	33	41	31	25	14	31	29	32	34	24	08	25	38	31	10	30
Small arms repair	49	40	42	31	41	41	37	38	36	47	45	43	39	33	38	49	42	33	37	42
Tank crewman	16	14	09	19	10	18	12	02	05	10	11	16	14	11	06	15	12	09	05	07
Field artillery fire control	49	49	46	39	45	33	56	58	58	54	55	40	36	37	56	39	38	28	42	51
Ammunition storage	29	40	39	33	33	34	32	38	35	32	34	35	25	23	32	29	34	24	34	43
Corrections specialist	20	27	23	20	16	22	16	20	10	13	12	20	15	16	11	24	12	16	13	22
Military police	33	37	38	29	35	33	27	36	27	31	29	33	32	29	28	33	35	26	27	37
Basic cannoneer	41	40	45	29	46	35	37	49	39	43	41	38	37	38	37	37	40	35	40	47
Basic electricity & electronics	20	33	35	14	25	20	21	36	26	27	26	28	11	15	19	20	26	17	34	16
Aviation machinists mate	32	32	33	15	30	25	28	31	29	31	31	29	19	29	30	32	31	23	35	27
Avionics technician	10	22	17	15	09	12	07	17	18	06	12	12	06	10	10	10	16	04	18	10

[a] Multiplied by 100.

[b] Marine Corps only.

[c] Army only.

TABLE C-3

UNCORRECTED MEANS AND STANDARD DEVIATIONS OF FCG VARIABLE

Course	Mean	Standard deviation
Basic supply stock clerk	82.4	7.7
Personal financial records clerk	83.9	7.2
Basic automotive mechanic	84.4	6.3
Advanced automotive mechanic	82.8	6.9
Basic baker	88.4	4.2
Basic food service	84.0	5.2
Basic combat engineer	83.0	6.8
Basic electrician	89.0	5.5
Electrical equipment repairman	82.9	6.1
Basic engineer equipment mechanic	86.3	5.6
Administrative clerk	83.5	7.2
Personnel clerk	89.8	5.2
Unit diary clerk	83.7	7.3
Sea duty indoctrination	81.9	5.9
Basic electronics	80.7	8.7
Radio fundamentals	81.8	6.2
Field radio operator	87.1	5.2
Communications center man	82.7	7.5
Air control electronic operator	81.0	5.6
Infantry training	83.8	7.6
Tracked vehicle repair	85.3	5.0
Basic helicopter	79.9	6.9
Aviation structural mechanic (safety equipment)	77.4	5.7
Aviation structural mechanic (hydraulics)	78.5	7.5
Aviation structural mechanic (structures)	77.2	5.9
Aviation ordnance	82.2	5.3
Aviation crash crew	84.2	5.3
Avionics repair	76.6	4.6
Air controlman	86.6	3.2
Aircraft launch & recovery	78.9	6.0
Aviation operations (clerical)	87.0	5.8
Aviation maintenance administration	77.8	7.9
Aviation supply (mechanical)	82.0	8.1
Aerographers mate	85.8	6.4
Small arms repair	88.6	5.4
Field artillery fire control	88.4	6.1
Ammunition storage	86.0	4.7
Basic cannoneer	89.5	4.4

APPENDIX D

CORRECTION FOR RESTRICTION OF RANGE

APPENDIX D

CORRECTION FOR RESTRICTION OF RANGE

In this appendix we discuss distortions of correlation coefficients by range restriction and examine two methods used to correct data for this distortion.

Figure D-1 illustrates range restriction. It shows the envelope of a typical scattergram that would result if a success criterion such as final course grade (y) were plotted against an ASVAB score (x) used to select recruits for a particular training course. Recruits with ASVAB scores below the minimum allowed for the course never attend the course. Data from these recruits (shaded area) will be missing from the sample. The sample is then said to be restricted. This restriction tends to reduce the size of the correlation measured between variables x and y .

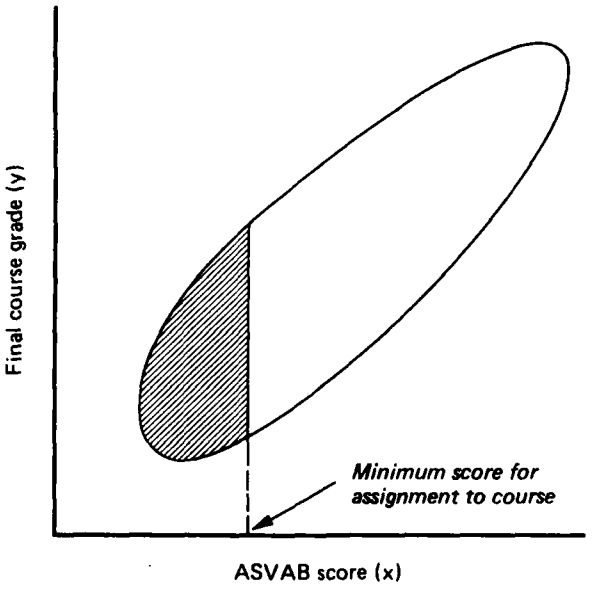

FIG. D-1: ILLUSTRATION OF RANGE RESTRICTION

SINGLE VARIABLE CORRECTION

One method of correcting for range restriction may be referred to as the single-variable method. With this method the corrected correlation between variables x and y is given in [D-1] as

$$R_{xy} = \frac{r_{xy} \frac{S_x}{s_x}}{\sqrt{1 - r_{xy}^2 + r_{xy}^2 \frac{S_x^2}{s_x^2}}} \qquad \text{(D-1)}$$

and

$$S_y = s_y \sqrt{1 - r_{xy}^2 + r_{xy}^2 \left(\frac{S_x^2}{s_x^2}\right)} \qquad \text{(D-2)}$$

where:

r_{xy} = the correlation between x and y in the restricted sample
s_x = the standard derivation of x in the restricted sample
s_y = the standard deviation of y in the restricted sample.

R_{xy}, S_x, and S_y are corresponding variables in the unrestricted sample. The values of r_{xy}, S_x, s_x, and s_y will be known and, hence, values of R_{xy} and S_y may be calculated using equations D-1 and D-2.

MULTIVARIABLE CORRECTION

In the multivariable case restrictions are assumed to have been made on more than one test score. The multivariable case is more realistic in our situation because selection for courses (and, hence, restriction) takes place directly or indirectly on all* ASVAB scores.

We use a multivariable range correction program developed by [D-2] using the matrix algebra methodology of Burt [D-3]. In this method the intercorrelations of all ASVAB scores in the unrestricted population are

* For example, recruits selected for course "A" with a GT prerequisite will be directly selected on GT. However, because the sample may have already been depleted of those recruits scoring high in other aptitudes (for assignment to other courses) the recruits in course "A" will have also been indirectly restricted on other tests in the ASVAB.

input as the "base matrix."* The restricted sample is represented by the intercorrelation matrix of all ASVAB scores (and final course grade) formed from the recruits in each training school. From these two matrixes (and variable means and standard deviations in both the restricted and unrestricted samples) a corrected correlation matrix is calculated. Complete matrix input and output are shown for one sample course (Basic Electronics) in annex D-1.

VALIDITY OF THE METHOD

We experimentally examined the validity of the two correction methods. For our experiment we selected recruits from the Administrative Clerk Course as an "experimental base population." We then simulated a restriction in this sample by removing all recruits who scored in the lower third on the ASVAB selector composite for that course (CL). We then corrected this restricted sample using both the single and multivariable procedures. Finally, we compared the resulting corrected correlations with those actually observed in our experimental base population. In table D-1 we tabulate the validities observed in our experimental base population, the simulated restricted sample, and as corrected by the single and multivariable procedure. We also tabulate the error introduced by the simulated restriction and the error remaining after applying the single and multivariable correction procedure.

We see from table D-1 that the simulated restriction does distort the observed validity coefficients. We also see that neither the single or multivariable correction procedure removes all of the distortion. Similar results were found by a simulated restriction on the Basic Automotive Mechanics Course followed by correction. These results are tabulated in table D-2. The results from tables D-1 and D-2 are summarized in table D-3. Table D-3 shows the mean of the absolute value of the errors found in our experiment. For example we see in the Administrative Clerk Course that a mean error of 0.06 in test score validities was induced by the simulated restriction. We also see that the single variable and the multivariable correction procedures reduced this mean error to 0.05 and 0.03, respectively. The results shown in table D-3 indicate that the multivariable correction procedure is preferable to either no correction or to the single variable procedure. However, it is clear that even the multivariable procedure leaves a significant residual error. Table D-3 indicates that neither correction procedure is useful for dichotomous variables. Further reference to tables D-1 and D-2 shows that the range of residual error

* A 23,106-case random sample of Marine Corps recruits entering recruit training during calendar year 1977 was selected to produce the base matrix. This is an appropriate population because it is the one from which recruits are selected for training on the basis of ASVAB scores.

TABLE D-1

EFFECT OF TWO CORRECTION PROCEDURES ON VALIDITY COEFFICIENTS FOR ADMINISTRATIVE CLERKS COURSE

	Validity coefficients				Error in correction		
Variable (1)	Base population (2)	Uncorrected after simulated restriction (3)	Corrected by multivariable procedure (4)	Corrected by single variable procedure (5)	Multi-variable procedure (6)[a]	Single variable procedure (7)[b]	Error induced by simulated restriction (8)[c]
GI	.12	.06	.12	.06	.00	.06	.06
NO	.37	.29	.40	.31	-.03	.06	.06
AD	.22	.10	.26	.11	-.04	.11	.12
WK	.35	.26	.42	.33	-.07	.02	.09
AR	.41	.33	.48	.38	-.07	.03	.08
SP	.23	.22	.27	.23	-.04	.00	.01
MK	.49	.45	.55	.49	-.06	.00	.04
EI	.26	.18	.27	.18	-.01	.08	.08
MC	.26	.20	.29	.19	-.03	.07	.06
GS	.37	.32	.41	.33	-.04	.04	.05
SI	.10	.05	.10	.05	.00	.05	.05
AI	.13	.07	.14	.07	-.01	.06	.06
CM	-.09	-.13	-.09	-.12	.00	.03	.04
CA	.20	.11	.24	.12	-.04	.08	.09
CE	.00	-.04	.02	-.04	-.02	.04	.04
CC	.11	.06	.13	.06	-.02	.05	.05
CO	.36	.26	.40	.30	-.04	.06	.10
FA	.47	.39	.51	.47	-.04	.00	.08
EL	.49	.43	.51	.49	-.02	.00	.06
OF	.24	.13	.25	.14	-.01	.10	.11
GM	.39	.30	.41	.33	-.02	.06	.09
MM	.26	.17	.27	.17	-.01	.09	.09
CL	.49	.43	.58	.59	-.09	-.10	.06
ST	.51	.48	.55	.55	-.04	-.04	.03
GT	.45	.39	.55	.50	-.10	-.05	.06
SC	.44	.37	.49	.45	-.05	-.01	.07
GCT	.45	.40	.53	.49	-.08	-.04	.05
ARMYEL	.29	.19	.32	.20	-.03	.09	.10
AIRM	.19	.12	.20	.12	-.01	.07	.07
AIRA	.44	.34	.42	.44	.02	.00	.10
AIRG	.43	.36	.44	.52	-.01	-.09	.07
AIRE	.40	.33	.43	.37	-.03	.03	.07

TABLE D-1 (Cont'd)

Variable (1)	Validity coefficients: Base population (2)	Validity coefficients: Uncorrected after simulated restriction (3)	Validity coefficients: Corrected by multivariable procedure (4)	Validity coefficients: Corrected by single variable procedure (5)	Error in correction: Multivariable procedure (6)[a]	Error in correction: Single variable procedure (7)[b]	Error in correction: Error induced by simulated restriction (8)[c]
NAVM	.30	.20	.35	.21	-.05	.09	.10
NAVC	.43	.32	.49	.39	-.06	-.04	.11
NAVG	.46	.39	.57	.49	-.11	-.03	.07
NAVE	.50	.44	.55	.49	-.05	.01	.06
AGE	.13	.14	.20	.14	-.07	-.01	-.01
EDUC	.26	.30	.32	.31	-.04	-.05	-.04
RACEW	.25	.21	.29	.23	-.04	.02	.04
RACEB	-.25	-.21	-.28	-.23	.03	-.02	-.04
SEX	-.31	-.26	-.34	-.26	.03	-.05	.05

[a] Column (2) minus column (4).

[b] Column (2) minus column (5).

[c] Column (2) minus column (3).

TABLE D-2

EFFECT OF TWO CORRECTION PROCEDURES ON VALIDITY COEFFICIENTS FOR AUTO MECHANICS COURSE

	Validity coefficients				Error in correction		
Variable (1)	Base population (2)	Uncorrected after simulated restriction (3)	Corrected by multivariable procedure (4)	Corrected by single variable procedure (5)	Multi-variable procedure (6)[a]	Single variable procedure (7)[b]	Error induced by simulated restriction (8)[c]
GI	.38	.21	.39	.24	-.01	.14	.17
NO	.18	.06	.16	.06	.02	.12	.12
AD	.02	.04	.06	.04	-.04	-.02	-.02
WK	.32	.25	.35	.27	-.03	.05	.07
AR	.39	.27	.38	.29	.01	.10	.12
SP	.20	.13	.18	.13	.02	.07	.07
MK	.33	.22	.34	.24	-.01	.10	.11
EI	.46	.29	.47	.37	-.01	.09	.07
MC	.46	.35	.47	.38	-.01	.08	.11
GS	.38	.31	.42	.33	-.04	.05	.07
SI	.45	.28	.49	.39	-.04	.06	.17
AI	.50	.37	.54	.45	-.04	.05	.13
CM	.19	.02	.18	.03	.01	.16	.17
CA	-.03	.01	.01	.01	-.04	-.04	-.04
CE	.03	.00	.05	.00	-.02	.03	.03
CC	.17	.07	.17	.07	.00	.10	.10
CO	.41	.27	.42	.31	-.01	.10	.14
FA	.50	.35	.48	.45	.02	.05	.15
EL	.53	.39	.50	.49	.03	.04	.14
OF	.48	.36	.50	.46	-.02	.02	.12
GM	.59	.49	.59	.60	.00	-.01	.10
MM	.59	.45	.61	.63	-.02	-.04	.14
CL	.31	.25	.34	.27	-.03	.04	.06
ST	.46	.33	.43	.39	.03	.07	.13
GT	.42	.32	.43	.36	-.01	.06	.10
SC	.49	.38	.48	.42	.01	.07	.11
GCT	.43	.31	.42	.35	.01	.08	.12

TABLE D-2 (Cont'd)

Variable (1)	Validity coefficients: Base population (2)	Validity coefficients: Uncorrected after simulated restriction (3)	Validity coefficients: Corrected by multivariable procedure (4)	Validity coefficients: Corrected by single variable procedure (5)	Error in correction: Multivariable procedure (6)[a]	Error in correction: Single variable procedure (7)[b]	Error in correction: Error induced by simulated restriction (8)[c]
ARMYEL	.54	.39	.53	.50	.01	.04	.15
AIRM	.56	.42	.52	.58	.04	-.02	.14
AIRA	.25	.15	.26	.16	-.01	.09	.10
AIRG	.42	.31	.40	.36	.02	.06	.11
AIRE	.48	.31	.38	.40	.10	.08	.17
NAVM	.54	.42	.61	.48	-.07	.06	.12
NAVC	.21	.14	.24	.15	-.03	.06	.07
NAVG	.43	.33	.44	.36	-.01	.07	.10
NAVE	.52	.39	.53	.45	-.01	.07	.13
AGE	.02	.06	.11	.06	-.09	-.04	-.04
EDUC	.21	.24	.28	.25	-.07	-.04	-.03
RACEW	.29	.15	.23	.18	.06	.11	.14
RACEB	-.28	-.13	-.18	-.17	-.10	-.11	-.15
SEX	.01	-.02	.10	-.02	-.09	.03	.03

[a] Column (2) minus column (4).

[b] Column (2) minus column (5).

[c] Column (2) minus column (3).

TABLE D-3

COMPARISON OF RESULTS FROM THE TWO CORRECTION TECHNIQUES

Course	Variable type	Mean of absolute errors in validity coefficients		
		Multivariable procedure	Single variable procedure	Induced by simulated restriction
Administrative clerk	Test score	.03	.05	.06
	Composite score[a]	.05	.05	.07
	Dichotomous[b]	.04	.04	.04
Basic automotive mechanic	Test score	.02	.08	.10
	Composite score[a]	.02	.05	.12
	Dichotomous[b]	.07	.06	.07

[a]Marine Corps only.
[b]EDUC, RACEW, SEX.

in the validities of tests and composites (after multivariable correction) varies from 0.00 to 0.11.

CORRECTION PROCEDURE USED IN THIS ANALYSIS

We use the multivariable correction procedure in this analysis. However, we note that it does not correct all distortion induced by range restriction. We estimate the residual uncorrected distortion in validity coefficients to range from 0.00 to 0.11.

REFERENCES

[D-1] Gulliksen, Harold. Theory of Mental Tests. New York: John Wiley and Sons, 1950

[D-2] CNA, Research Contribution 336, "A Method to Correct Correlation Coefficients for the Effects of Multiple Curtailment," by Thomas L. Mifflin and Steven M. Verna, Unclassified, Aug 1977

[D-3] Burt, Cyril. "Validating Tests for Personnel Selection," British Journal of Psychology 34 (1943) : 1-19

ANNEX D-1

SAMPLE RANGE CORRECTION PROGRAM INPUT AND OUTPUT

ANNEX D-1

SAMPLE RANGE CORRECTION PROGRAM INPUT AND OUTPUT

The means and standard deviation of the tests and composites of the base population are shown in table D-1-1. The variable definitions are as given in appendix B; except that the prefix "ARMY" indicates an Army-only composite, "AIR" indicates an Air Force composite, and "NAV" indicates a Navy composite. The correlation coefficients between the various test scores in the base population are shown in table D-1-2. Similar tables of uncorrected data from one course (Basic Electronics) are shown in tables D-1-3 and D-1-4. Tables D-1-1, D-1-2, D-1-3, and D-1-4 are input to the correction program. Sample output tables of corrected data (Basic Electronics) are shown in tables D-1-5 and D-1-6.

TABLE D-1-1

BASE MATRIX MEANS AND STANDARD DEVIATIONS

VARIABLE	MEAN	STANDARD DEV
GI	9.41	2.93
NO	31.27	9.81
AO	14.92	4.71
MK	19.53	6.04
AR	12.05	4.16
SP	12.83	3.81
MK	10.87	4.49
EI	18.04	5.47
MC	10.75	3.97
GS	10.38	3.80
SI	13.45	4.03
AI	11.11	4.55
CM	12.01	4.88
CA	9.90	3.17
CE	7.77	4.47
CC	17.64	4.01
CO	101.43	18.94
FA	101.84	18.04
EL	101.25	17.68
OF	101.49	19.32
GM	100.97	17.77
MM	100.55	19.62
CL	103.59	17.80
ST	102.64	17.18
GT	102.96	16.51
SC	102.04	16.60
GCT	102.29	16.43
ARMYEL	103.98	16.58
AIRM	55.03	25.40
AIRA	52.85	25.15
AIRG	57.13	24.68
AIRF	57.32	25.45
NAVM	153.11	19.69
NAVC	152.46	19.07
NAVG	101.93	14.03
NAVE	202.69	27.99
AGE	18.87	1.91
EDUC	0.66	0.47
RACEW	0.72	0.44
RACEB	0.22	0.41
SEX	0.96	0.19

TABLE D-1-2

BASE POPULATION CORRELATION MATRIX

	GI	NO	AO	MK	AR	SP	MK	EI	MC	GS	SI	AI
GI	1.00	0.28	0.06	0.54	0.43	0.27	0.42	0.52	0.48	0.54	0.49	0.47
NO	0.28	1.00	0.37	0.30	0.48	0.19	0.52	0.28	0.29	0.32	0.20	0.16
AO	0.06	0.37	1.00	0.10	0.21	0.15	0.23	0.10	0.13	0.11	0.06	0.01
MK	0.54	0.30	0.10	1.00	0.52	0.27	0.49	0.51	0.47	0.65	0.37	0.36
AR	0.43	0.48	0.21	0.52	1.00	0.37	0.67	0.46	0.52	0.53	0.38	0.36
SP	0.27	0.19	0.15	0.27	0.37	1.00	0.36	0.38	0.51	0.33	0.34	0.30
MK	0.42	0.52	0.23	0.49	0.67	0.36	1.00	0.46	0.50	0.54	0.32	0.29
FI	0.52	0.28	0.10	0.51	0.46	0.38	0.46	1.00	0.60	0.60	0.60	0.59
MC	0.48	0.29	0.13	0.47	0.52	0.51	0.50	0.60	1.00	0.59	0.59	0.55
GS	0.54	0.32	0.11	0.65	0.53	0.33	0.54	0.60	0.59	1.00	0.50	0.46
SI	0.49	0.20	0.06	0.37	0.38	0.34	0.32	0.60	0.59	0.50	1.00	0.65
AI	0.47	0.16	0.01	0.36	0.36	0.30	0.29	0.59	0.55	0.46	0.65	1.00
CM	0.15	0.02	0.00	0.02	0.10	0.16	0.03	0.30	0.27	0.12	0.38	0.46
CA	0.05	0.20	0.13	0.17	0.18	0.04	0.21	0.09	0.04	0.14	-0.03	-0.02
CE	0.11	0.19	0.11	0.14	0.25	0.18	0.29	0.25	0.21	0.21	0.11	0.11
CC	0.36	0.20	0.09	0.31	0.28	0.20	0.24	0.33	0.35	0.33	0.37	0.31
CO	0.50	0.47	0.52	0.49	0.70	0.63	0.57	0.53	0.65	0.56	0.67	0.50
FA	0.67	0.51	0.21	0.63	0.78	0.42	0.79	0.78	0.63	0.68	0.53	0.51
EL	0.59	0.49	0.20	0.65	0.79	0.44	0.79	0.81	0.67	0.79	0.57	0.53
DF	0.72	0.31	0.08	0.51	0.48	0.31	0.44	0.62	0.55	0.57	0.59	0.50
GM	0.60	0.40	0.15	0.61	0.75	0.46	0.61	0.70	0.82	0.79	0.67	0.76
MM	0.56	0.33	0.12	0.47	0.53	0.42	0.57	0.82	0.68	0.60	0.79	0.81
LL	0.46	0.52	0.55	0.77	0.73	0.33	0.62	0.49	0.48	0.59	0.34	0.30
ST	0.54	0.53	0.22	0.63	0.85	0.41	0.85	0.54	0.61	0.79	0.47	0.43
GT	0.56	0.43	0.17	0.70	0.80	0.35	0.63	0.55	0.55	0.68	0.43	0.40
SC	0.57	0.42	0.19	0.80	0.77	0.65	0.64	0.63	0.78	0.69	0.54	0.50
GCT	0.55	0.42	0.19	0.34	0.78	0.64	0.64	0.58	0.63	0.67	0.47	0.43
ARMYEL	0.56	0.40	0.17	0.56	0.71	0.48	0.61	0.83	0.79	0.67	0.74	0.63
AIRM	0.56	0.25	0.08	0.46	0.68	0.43	0.42	0.69	0.81	0.59	0.87	0.86
AIRA	0.41	0.47	0.57	0.61	0.58	0.27	0.60	0.41	0.41	0.49	0.30	0.25
AING	0.56	0.42	0.16	0.91	0.80	0.35	0.62	0.55	0.55	0.67	0.43	0.41
AIRE	0.53	0.41	0.19	0.55	0.75	0.69	0.62	0.83	0.69	0.62	0.58	0.55
NAVM	0.62	0.32	0.12	0.75	0.58	0.46	0.53	0.70	0.85	0.71	0.81	0.64
NAVC	0.36	0.76	0.75	0.59	0.56	0.27	0.55	0.38	0.39	0.47	0.28	0.21
NAVG	0.55	0.45	0.18	0.85	0.87	0.36	0.66	0.55	0.56	0.67	0.43	0.40
NAVE	0.58	0.49	0.21	0.66	0.81	0.44	0.82	0.77	0.68	0.32	0.55	0.52
AGE	-0.03	-0.01	0.03	0.07	0.00	-0.02	-0.02	0.00	-0.06	0.00	-0.06	0.01
EDUC	0.11	0.15	0.07	0.09	0.11	0.03	0.20	0.09	0.07	0.15	0.02	0.05
RACEW	0.37	0.20	0.03	0.29	0.33	0.19	0.26	0.33	0.38	0.32	0.45	0.40
RACEB	-0.35	-0.21	-0.04	-0.25	-0.30	-0.22	-0.25	-0.32	-0.37	-0.30	-0.44	-0.39
SEX	0.10	-0.17	-0.15	-0.17	-0.12	-0.06	-0.14	0.03	0.02	-0.10	0.16	0.12

TABLE D-1-2 (Cont'd)

	CM	CA	CE	CC	CO	FA	EL	OF	GM	MM	CL	ST
GI	0.15	0.05	0.11	0.36	0.50	0.67	0.59	0.72	0.60	0.55	0.46	0.56
NU	0.02	0.20	0.19	0.20	0.47	0.51	0.49	0.31	0.40	0.33	0.52	0.53
AD	0.00	0.13	0.11	0.09	0.52	0.21	0.20	0.08	0.15	0.12	0.55	0.72
HK	0.02	0.17	0.14	0.31	0.49	0.63	0.65	0.51	0.61	0.47	0.77	0.63
AR	0.10	0.18	0.25	0.28	0.70	0.78	0.79	0.68	0.75	0.53	0.73	0.85
SP	0.16	0.04	0.18	0.20	0.63	0.42	0.44	0.31	0.46	0.42	0.33	0.41
MK	0.03	0.21	0.29	0.24	0.57	0.79	0.79	0.44	0.61	0.57	0.67	0.85
EI	0.30	0.09	0.25	0.33	0.53	0.78	0.81	0.62	0.70	0.82	0.49	0.59
MC	0.27	0.04	0.21	0.35	0.65	0.63	0.67	0.55	0.82	0.68	0.48	0.61
GS	0.12	0.14	0.21	0.33	0.56	0.68	0.79	0.57	0.79	0.60	0.59	0.79
SI	0.38	-0.03	0.11	0.37	0.67	0.53	0.57	0.59	0.67	0.79	0.34	0.47
AI	0.46	-0.02	0.11	0.31	0.50	0.51	0.53	0.80	0.76	0.81	0.30	0.43
CM	1.00	0.10	0.39	0.34	0.30	0.21	0.19	0.39	0.31	0.60	0.08	0.10
CA	0.10	1.00	0.43	0.10	0.14	0.38	0.19	0.44	0.10	0.10	0.47	0.21
CE	0.39	0.43	1.00	0.18	0.26	0.36	0.30	0.30	0.23	0.32	0.31	0.28
CC	0.34	0.10	0.18	1.00	0.61	0.38	0.37	0.39	0.41	0.44	0.32	0.34
CO	0.30	0.14	0.26	0.61	1.00	0.73	0.74	0.58	0.76	0.72	0.74	0.72
FA	0.21	0.38	0.36	0.38	0.73	1.00	0.94	0.76	0.82	0.78	0.78	0.89
FL	0.19	0.19	0.30	0.37	0.74	0.94	1.00	0.66	0.88	0.90	0.75	0.94
OF	0.39	0.44	0.30	0.39	0.58	0.76	0.66	1.00	0.76	0.79	0.58	0.58
GM	0.31	0.10	0.23	0.41	0.76	0.82	0.88	0.76	1.00	0.83	0.66	0.84
MM	0.60	0.10	0.32	0.44	0.72	0.78	0.80	0.78	0.83	1.00	0.50	0.67
CL	0.08	0.47	0.31	0.32	0.74	0.78	0.75	0.58	0.66	0.50	1.00	0.75
ST	0.10	0.21	0.28	0.34	0.72	0.89	0.94	0.58	0.84	0.67	0.75	1.00
GT	0.06	0.20	0.21	0.34	0.65	0.73	0.80	0.57	0.76	0.57	0.86	0.82
SC	0.16	0.15	0.24	0.38	0.79	0.80	0.83	0.61	0.85	0.58	0.79	0.81
GCT	0.11	0.18	0.23	0.35	0.76	0.79	0.91	0.57	0.78	0.61	0.82	0.91
ARMYEL	0.40	0.20	0.50	0.42	0.79	0.87	0.98	0.71	0.83	0.88	0.65	0.77
AIRM	0.43	-0.01	0.15	0.40	0.70	0.64	0.68	0.76	0.97	0.98	0.43	0.59
AIRA	0.02	0.23	0.21	0.28	0.65	0.64	0.63	0.43	0.54	0.43	0.80	0.65
AING	0.05	0.19	0.19	0.34	0.65	0.78	0.79	0.57	0.75	0.56	0.85	0.81
AINE	0.25	0.13	0.27	0.35	0.80	0.85	0.88	0.61	0.82	0.78	0.65	0.78
NAVM	0.28	0.07	0.19	0.42	0.74	0.73	0.77	0.68	0.87	0.80	0.65	0.79
NAVC	0.01	0.23	0.20	0.27	0.69	0.59	0.59	0.39	0.51	0.40	0.85	0.61
NAVG	0.06	0.20	0.22	0.34	0.68	0.81	0.82	0.56	0.78	0.57	0.86	0.85
NAVE	0.17	0.19	0.31	0.36	0.74	0.93	0.98	0.64	0.88	0.77	0.74	0.95
AGE	-0.01	0.15	0.10	-0.07	-0.03	0.01	-0.01	0.06	-0.01	-0.02	0.08	-0.01
EDUC	-0.05	0.11	0.07	-0.00	0.07	0.17	0.15	0.11	0.10	0.08	0.14	0.17
RACEW	0.15	-0.11	-0.05	0.32	0.41	0.35	0.39	0.35	0.46	0.44	0.24	0.35
RACEB	-0.17	0.13	0.05	-0.31	-0.41	-0.33	-0.37	-0.33	-0.44	-0.43	-0.21	-0.33
SEX	0.15	-0.16	0.03	0.03	-0.05	-0.08	-0.09	0.04	-0.02	0.08	-0.22	-0.14

TABLE D-1-2 (Cont'd)

	GT	SC	GCT	ARMYEL	AIRM	AIRA	AIRG	AIRE	NAVM	NAVC	NAVG	NAVE
GT	0.56	0.[illegible]7	0.55	0.56	0.56	0.41	0.56	0.53	0.62	0.36	0.55	0.58
NO	0.43	0.42	0.42	0.40	0.2[illegible]	0.87	0.42	0.41	0.32	0.76	0.45	0.49
AD	0.17	0.19	0.19	0.17	0.03	0.57	0.16	0.19	0.12	0.75	0.18	0.21
BK	0.90	0.80	0.84	0.56	0.46	0.61	0.91	0.55	0.75	0.53	0.85	0.66
AR	0.80	0.77	0.78	0.71	0.43	0.58	0.80	0.75	0.58	0.54	0.87	0.81
SP	0.35	0.65	0.64	0.43	0.43	0.27	0.35	0.69	0.46	0.27	0.36	0.44
MK	0.63	0.64	0.64	0.61	0.42	0.60	0.62	0.62	0.53	0.55	0.66	0.82
EI	0.55	0.63	0.58	0.83	0.69	0.41	0.55	0.83	0.70	0.39	0.55	0.77
MC	0.55	0.78	0.63	0.79	0.81	0.41	0.55	0.69	0.85	0.39	0.56	0.69
GS	0.68	0.69	0.67	0.67	0.59	0.49	0.67	0.62	0.71	0.47	0.67	0.82
SI	0.43	0.54	0.47	0.74	0.87	0.30	0.43	0.58	0.81	0.28	0.43	0.55
AI	0.40	0.50	0.43	0.63	0.86	0.25	0.41	0.55	0.64	0.21	0.40	0.52
CM	0.05	0.16	0.11	0.40	0.43	0.02	0.06	0.25	0.28	0.01	0.06	0.17
CA	0.20	0.15	0.18	0.20	-0.01	0.23	0.19	0.13	0.07	0.23	0.20	0.19
CF	0.21	0.24	0.23	0.50	0.15	0.21	0.19	0.27	0.19	0.20	0.22	0.31
CC	0.34	0.38	0.35	0.42	0.40	0.28	0.34	0.35	0.42	0.27	0.34	0.36
LO	0.65	0.79	0.76	0.79	0.70	0.65	0.65	0.80	0.74	0.69	0.68	0.74
FA	0.78	0.80	0.79	0.87	0.64	0.64	0.78	0.85	0.73	0.59	0.81	0.93
EL	0.89	0.83	0.81	0.88	0.69	0.63	0.79	0.88	0.77	0.59	0.92	0.93
UF	0.57	0.61	0.57	0.71	0.76	0.43	0.57	0.61	0.68	0.39	0.56	0.64
GM	0.76	0.85	0.78	0.88	0.47	0.54	0.75	0.82	0.87	0.51	0.78	0.88
MM	0.57	0.68	0.61	0.88	0.89	0.43	0.56	0.73	0.80	0.40	0.57	0.77
CL	0.86	0.79	0.82	0.65	0.43	0.80	0.85	0.65	0.65	0.85	0.86	0.74
ST	0.82	0.81	0.81	0.77	0.58	0.65	0.81	0.78	0.70	0.61	0.85	0.95
GT	1.00	0.90	0.93	0.70	0.53	0.68	0.97	0.71	0.77	0.65	0.98	0.81
SC	0.90	1.00	0.97	0.81	0.69	0.54	0.89	0.85	0.87	0.61	0.89	0.94
GCT	0.93	0.97	1.00	0.74	0.58	0.65	0.92	0.83	0.79	0.63	0.92	0.82
ARMYEL	0.70	0.81	0.74	1.00	0.83	0.53	0.69	0.87	0.86	0.50	0.72	0.86
AIRM	0.53	0.69	0.58	0.83	1.00	0.37	0.53	0.70	0.87	0.34	0.53	0.67
AIRA	0.68	0.64	0.65	0.53	0.37	1.00	0.68	0.54	0.54	0.94	0.68	0.64
AIRG	0.97	0.89	0.92	0.69	0.53	0.68	1.00	0.72	0.77	0.64	0.97	0.81
AIRE	0.71	0.85	0.83	0.87	0.70	0.54	0.72	1.00	0.75	0.50	0.74	0.86
NAVM	0.77	0.87	0.79	0.86	0.87	0.54	0.77	0.75	1.00	0.52	0.76	0.78
NAVC	0.65	0.61	0.63	0.50	0.34	0.94	0.64	0.50	0.52	1.00	0.65	0.60
NAVG	0.98	0.89	0.92	0.72	0.53	0.68	0.97	0.74	0.76	0.65	1.00	0.84
NAVE	0.81	0.84	0.82	0.86	0.67	0.64	0.81	0.86	0.78	0.60	0.84	1.00
AGE	0.05	0.00	0.03	-0.00	-0.05	0.02	0.03	-0.01	-0.01	0.04	0.04	-0.00
EDUC	0.10	0.09	0.09	0.10	0.04	0.16	0.10	0.09	0.08	0.15	0.11	0.17
RACEN	0.35	0.39	0.35	0.40	0.49	0.26	0.36	0.38	0.46	0.22	0.35	0.38
RACEB	-0.31	-0.37	-0.33	-0.38	-0.48	-0.25	-0.32	-0.38	-0.43	-0.21	-0.31	-0.36
SEX	-0.16	-0.11	-0.15	0.03	0.12	-0.21	-0.16	-0.06	0.00	-0.23	-0.17	-0.10

TABLE D-1-2 (Cont'd)

	AGE	EDUC	RACEW	RACEB	SEX
GI	-0.03	0.11	0.37	-0.35	0.10
NO	-0.01	0.15	0.20	-0.21	-0.17
AD	0.03	0.07	0.03	-0.04	-0.15
MK	0.07	0.09	0.29	-0.25	-0.17
AR	0.00	0.11	0.33	-0.30	-0.12
SP	-0.02	0.03	0.19	-0.22	-0.06
MK	-0.02	0.20	0.26	-0.25	-0.14
EI	0.00	0.07	0.33	-0.32	0.03
MC	-0.06	0.07	0.38	-0.37	0.02
GS	0.00	0.15	0.32	-0.30	-0.10
SI	-0.06	0.02	0.45	-0.44	0.16
AI	0.01	0.03	0.40	-0.39	0.12
CM	-0.01	-0.05	0.15	-0.17	0.15
CA	0.15	0.11	-0.11	0.13	-0.16
CE	0.10	0.07	-0.05	0.05	0.03
CC	-0.07	-0.00	0.32	-0.31	0.03
CO	-0.03	0.07	0.41	-0.41	-0.05
FA	0.01	0.17	0.35	-0.33	-0.08
EL	-0.01	0.15	0.39	-0.37	-0.09
OF	0.06	0.11	0.35	-0.33	0.04
GM	-0.01	0.10	0.46	-0.44	-0.02
MM	-0.02	0.08	0.44	-0.43	0.08
CL	0.08	0.14	0.24	-0.21	-0.22
ST	-0.01	0.17	0.35	-0.33	-0.14
GT	0.05	0.10	0.35	-0.31	-0.15
SC	0.00	0.09	0.39	-0.37	-0.11
GCT	0.03	0.09	0.35	-0.33	-0.15
ARMYEL	-0.00	0.13	0.40	-0.38	0.03
AIRM	-0.05	0.04	0.49	-0.48	0.12
AIRA	0.02	0.16	0.26	-0.25	-0.21
AIRG	0.03	0.10	0.36	-0.32	-0.16
AIRE	-0.01	0.09	0.38	-0.33	-0.06
NAVM	-0.01	0.08	0.46	-0.43	0.00
NAVC	0.04	0.15	0.22	-0.21	-0.23
NAVG	0.04	0.11	0.35	-0.31	-0.17
NAVE	-0.00	0.17	0.38	-0.36	-0.10
AGE	1.00	0.17	-0.13	0.13	-0.10
EDUC	0.17	1.00	-0.07	0.06	-0.09
RACEW	-0.13	-0.07	1.00	-0.87	-0.04
RACEB	0.13	0.06	-0.87	1.00	0.03
SEX	-0.10	-0.09	-0.04	0.03	1.00

TABLE D-1-3

BEC UNCORRECTED MATRIX MEANS AND STANDARD DEVIATIONS

VARIABLE	MEAN	STANDARD DEV
GI	11.47	2.27
ND	56.64	9.15
AD	16.08	4.67
MK	25.39	3.83
AR	16.40	2.96
SP	15.16	3.29
MK	15.76	5.49
EI	23.02	4.29
MC	14.14	3.58
GS	14.62	2.99
SI	15.78	3.31
AI	15.61	4.25
CM	12.64	4.80
CA	10.65	2.82
CE	11.57	4.59
CC	19.21	5.49
CO	118.11	13.82
FA	121.70	11.47
EL	122.06	10.94
UF	115.38	15.01
GM	118.83	12.56
MM	117.57	13.19
CL	120.93	12.15
ST	121.81	10.95
GT	121.17	11.03
SC	120.16	10.94
GCT	120.30	10.55
ARMYEL	122.77	12.46
AIRM	73.53	20.35
AIRA	73.01	19.68
AIRG	83.49	11.71
AIRE	82.89	13.30
NAVM	172.46	15.49
NAVC	167.25	16.67
NAVG	118.09	9.56
NAVE	236.64	18.66
AGE	19.17	1.90
EDUC	0.89	0.30
RACEW	0.86	0.37
RACEB	0.10	0.30
SEX	0.93	0.24
FCG	80.68	8.67

TABLE D-1-4

BEC UNCORRECTED CORRELATION MATRIX

	GI	ND	AD	HK	AH	SP	MK	EI	MC	GS	SI	AI
GI	1.00	0.01	-0.02	0.39	0.18	0.20	0.19	0.39	0.35	0.42	0.40	0.39
ND	0.01	1.00	0.38	0.12	0.33	0.09	0.35	-0.00	0.06	0.13	-0.03	-0.05
AD	-0.02	0.38	1.00	0.04	0.19	0.05	0.20	-0.04	0.02	0.02	-0.03	-0.10
HK	0.39	0.12	0.04	1.00	0.26	0.16	0.26	0.35	0.27	0.47	0.18	0.16
AH	0.18	0.33	0.19	0.26	1.00	0.22	0.58	0.19	0.30	0.28	0.16	0.12
SP	0.20	0.09	0.05	0.16	0.22	1.00	0.26	0.26	0.47	0.25	0.27	0.29
MK	0.19	0.35	0.20	0.26	0.58	0.26	1.00	0.19	0.24	0.31	0.10	0.10
EI	0.39	-0.00	-0.04	0.35	0.19	0.26	0.19	1.00	0.51	0.41	0.51	0.53
MC	0.35	0.06	0.02	0.27	0.30	0.47	0.24	0.51	1.00	0.48	0.57	0.50
GS	0.42	0.13	0.02	0.47	0.28	0.25	0.31	0.41	0.48	1.00	0.41	0.38
SI	0.40	-0.03	-0.03	0.18	0.16	0.27	0.10	0.51	0.57	0.41	1.00	0.64
AI	0.39	-0.05	-0.10	0.16	0.12	0.29	0.10	0.53	0.50	0.38	0.64	1.00
CM	0.15	-0.07	-0.07	-0.00	0.04	0.22	-0.00	0.32	0.33	0.13	0.41	0.53
CA	-0.07	0.18	0.15	0.11	0.15	0.05	0.14	-0.00	-0.03	0.00	-0.08	-0.10
CE	0.15	0.14	0.10	0.11	0.21	0.20	0.27	0.29	0.28	0.22	0.18	0.15
CC	0.24	0.02	0.03	0.19	0.17	0.12	0.08	0.22	0.22	0.24	0.28	0.24
CO	0.32	0.30	0.55	0.28	0.57	0.55	0.41	0.37	0.52	0.40	0.55	0.34
FA	0.51	0.28	0.15	0.46	0.67	0.34	0.69	0.66	0.48	0.43	0.38	0.37
LL	0.43	0.27	0.12	0.49	0.67	0.36	0.70	0.70	0.55	0.69	0.44	0.42
UF	0.62	0.05	-0.00	0.32	0.23	0.30	0.21	0.52	0.48	0.44	0.58	0.61
GM	0.47	0.14	0.02	0.40	0.54	0.44	0.40	0.59	0.80	0.72	0.64	0.75
MM	0.44	0.04	-0.02	0.27	0.30	0.37	0.37	0.75	0.61	0.67	0.74	0.82
EL	0.19	0.43	0.67	0.53	0.61	0.19	0.47	0.19	0.22	0.32	0.09	0.02
ST	0.33	0.36	0.19	0.43	0.76	0.32	0.80	0.34	0.44	0.68	0.28	0.25
GT	0.36	0.27	0.15	0.81	0.71	0.24	0.49	0.35	0.36	0.48	0.21	0.13
SC	0.41	0.21	0.10	0.64	0.61	0.66	0.47	0.49	0.75	0.55	0.43	0.40
GCT	0.37	0.25	0.13	0.71	0.66	0.65	0.51	0.39	0.50	0.50	0.29	0.28
ARNTEL	0.43	0.14	0.07	0.35	0.50	0.41	0.39	0.76	0.76	0.53	0.69	0.57
AIHM	0.45	-0.00	-0.04	0.23	0.25	0.39	0.17	0.61	0.79	0.49	0.86	0.84
AIHA	0.12	0.89	0.59	0.38	0.37	0.13	0.40	0.09	0.14	0.24	0.03	-0.01
AIHG	0.36	0.24	0.12	0.44	0.69	0.22	0.47	0.35	0.33	0.47	0.23	0.18
AIHE	0.37	0.16	0.07	0.34	0.57	0.65	0.43	0.74	0.58	0.62	0.66	0.64
NAVM	0.49	0.06	0.01	0.56	0.31	0.41	0.26	0.61	0.84	0.59	0.80	0.80
NAVC	0.11	0.74	0.41	0.40	0.37	0.12	0.38	0.09	0.14	0.24	0.02	-0.04
NAVG	0.32	0.30	0.17	0.73	0.92	0.23	0.54	0.33	0.36	0.47	0.20	0.15
NAVE	0.42	0.28	0.14	0.49	0.71	0.36	0.72	0.64	0.55	0.72	0.42	0.40
AGE	0.05	0.03	0.03	0.20	0.05	0.04	0.04	0.06	-0.00	0.02	-0.02	0.02
EDUC	0.07	0.04	0.08	0.03	0.00	-0.01	0.06	0.06	0.00	0.01	-0.01	0.00
MALEN	0.24	0.13	0.05	0.17	0.27	0.14	0.20	0.23	0.30	0.25	0.37	0.28
MACFA	-0.23	-0.14	-0.06	-0.15	-0.24	-0.17	-0.22	-0.20	-0.29	-0.24	-0.37	-0.29
SFI	0.30	-0.19	-0.17	-0.11	-0.02	0.01	-0.00	0.27	0.16	0.02	0.31	0.30
FCG	0.22	0.27	0.18	0.23	0.37	0.26	0.45	0.32	0.34	0.36	0.18	0.21

TABLE D-1-4 (Cont'd)

	CM	CA	CE	CC	CO	FA	FL	OF	GM	MM	CL	ST
GI	0.15	-0.07	0.13	0.24	0.42	0.51	0.43	0.62	0.47	0.44	0.19	0.33
NO	-0.07	0.18	0.14	0.02	0.30	0.28	0.27	0.05	0.14	0.04	0.43	0.36
AD	-0.07	0.15	0.10	0.03	0.55	0.15	0.12	-0.00	0.02	-0.02	0.67	0.19
MK	-0.00	0.11	0.11	0.19	0.24	0.46	0.49	0.32	0.40	0.27	0.58	0.43
AR	0.04	0.15	0.21	0.17	0.57	0.67	0.67	0.23	0.54	0.30	0.61	0.76
SP	0.22	0.05	0.20	0.12	0.55	0.34	0.36	0.30	0.44	0.37	0.19	0.32
MK	-0.00	0.14	0.27	0.08	0.41	0.69	0.70	0.21	0.40	0.37	0.47	0.40
EI	0.32	-0.00	0.29	0.22	0.37	0.66	0.70	0.52	0.59	0.75	0.19	0.36
MC	0.33	-0.03	0.28	0.22	0.52	0.48	0.55	0.43	0.80	0.61	0.22	0.44
GS	0.13	0.00	0.22	0.24	0.40	0.48	0.69	0.44	0.72	0.47	0.32	0.64
SI	0.41	-0.06	0.18	0.28	0.55	0.18	0.44	0.58	0.64	0.74	0.09	0.29
AI	0.53	-0.10	0.15	0.24	0.38	0.37	0.42	0.81	0.75	0.92	0.02	0.25
CM	1.00	0.09	0.42	0.37	0.31	0.22	0.19	0.48	0.39	0.69	-0.00	0.06
CA	0.09	1.00	0.37	0.05	0.13	0.37	0.10	0.37	0.00	0.02	0.51	0.12
CE	0.42	0.37	1.00	0.18	0.30	0.44	0.36	0.34	0.30	0.39	0.30	0.31
CC	0.37	0.05	0.18	1.00	0.55	0.24	0.25	0.29	0.30	0.36	0.18	0.20
CO	0.31	0.13	0.30	0.55	1.00	0.60	0.61	0.46	0.63	0.57	0.66	0.59
FA	0.22	0.37	0.44	0.24	0.60	1.00	0.90	0.65	0.69	0.67	0.44	0.79
FL	0.19	0.10	0.36	0.25	0.61	0.90	1.00	0.52	0.79	0.70	0.54	0.49
OF	0.48	0.37	0.34	0.29	0.46	0.65	0.52	1.00	0.72	0.76	0.33	0.37
GM	0.39	0.00	0.30	0.30	0.63	0.69	0.79	0.72	1.00	0.80	0.37	0.70
MM	0.69	0.02	0.39	0.36	0.57	0.67	0.70	0.76	0.80	1.00	0.21	0.48
CL	-0.00	0.51	0.30	0.18	0.66	0.64	0.54	0.33	0.37	0.21	1.00	0.59
ST	0.06	0.12	0.31	0.20	0.59	0.79	0.89	0.37	0.70	0.48	0.59	1.00
GT	0.02	0.16	0.20	0.21	0.50	0.69	0.71	0.35	0.58	0.35	0.73	0.73
SC	0.21	0.10	0.29	0.25	0.68	0.71	0.75	0.50	0.80	0.57	0.58	0.71
GCT	0.12	0.15	0.25	0.22	0.65	0.70	0.72	0.42	0.65	0.45	0.66	0.72
ARMYEL	0.46	0.14	0.53	0.32	0.66	0.78	0.79	0.64	0.82	0.83	0.41	0.60
AINM	0.49	-0.10	0.23	0.30	0.57	0.48	0.55	0.72	0.84	0.85	0.12	0.37
AINA	-0.07	0.20	0.17	0.07	0.49	0.18	0.37	0.13	0.23	0.11	0.68	0.44
AING	0.02	0.16	0.19	0.23	0.49	0.66	0.67	0.34	0.55	0.35	0.72	0.67
AINE	0.29	0.08	0.32	0.26	0.66	0.75	0.76	0.50	0.68	0.64	0.41	0.58
NAVM	0.35	-0.00	0.25	0.30	0.60	0.58	0.65	0.62	0.83	0.74	0.36	0.50
NAVC	-0.08	0.22	0.17	0.09	0.57	0.39	0.37	0.12	0.22	0.09	0.61	0.44
NAVG	0.01	0.17	0.21	0.22	0.54	0.72	0.73	0.32	0.58	0.34	0.74	0.77
NAVE	0.17	0.10	0.36	0.25	0.62	0.89	0.95	0.50	0.80	0.67	0.56	0.92
AGE	0.02	0.13	0.03	-0.00	0.04	0.11	0.07	0.10	0.04	0.04	0.17	0.06
EDUC	-0.00	0.00	0.0	-0.04	0.01	0.07	0.06	0.03	0.01	0.03	0.06	0.05
RACEN	0.16	-0.04	0.0	0.22	0.36	0.29	0.32	0.27	0.37	0.35	0.18	0.29
RACE6	-0.17	0.01	-0.06	-0.24	-0.37	-0.28	-0.30	-0.29	-0.35	-0.34	-0.18	-0.28
SEX	0.21	-0.12	0.08	0.11	0.06	0.11	0.08	0.27	0.18	0.29	-0.20	-0.05
FCG	0.10	0.10	0.34	0.09	0.37	0.50	0.53	0.29	0.43	0.36	0.35	0.51

TABLE D-1-4 (Cont'd)

	GI	SC	GCT	ARMYEL	AIRM	AIRA	AING	AIRF	NAVM	NAVC	NAVG	NAVE
GI	0.36	0.41	0.37	0.43	0.45	0.12	0.36	0.37	0.49	0.11	0.52	0.42
MO	0.27	0.21	0.25	0.14	-0.00	0.89	0.24	0.16	0.06	0.74	0.30	0.28
AD	0.15	0.10	0.13	0.07	-0.04	0.59	0.12	0.07	0.01	0.31	0.17	0.14
MK	0.81	0.64	0.71	0.35	0.23	0.36	0.84	0.36	0.56	0.40	0.75	0.69
AR	0.71	0.61	0.66	0.50	0.23	0.37	0.69	0.57	0.31	0.37	0.82	0.71
SP	0.24	0.66	0.45	0.41	0.39	0.13	0.22	0.65	0.41	0.12	0.23	0.36
MK	0.49	0.47	0.51	0.39	0.17	0.40	0.47	0.43	0.26	0.38	0.54	0.72
EI	0.35	0.49	0.39	0.76	0.61	0.09	0.35	0.74	0.61	0.09	0.33	0.64
MC	0.36	0.75	0.50	0.76	0.79	0.14	0.33	0.58	0.84	0.14	0.36	0.55
GS	0.48	0.55	0.30	0.53	0.49	0.24	0.47	0.42	0.59	0.24	0.47	0.72
SI	0.21	0.43	0.29	0.69	0.46	0.03	0.23	0.46	0.80	0.02	0.20	0.42
AI	0.18	0.40	0.28	0.57	0.84	-0.01	0.18	0.44	0.63	-0.04	0.15	0.40
CM	0.02	0.21	0.12	0.46	0.49	-0.07	0.02	0.23	0.35	-0.08	0.01	0.17
CA	0.16	0.10	0.15	0.14	-0.10	0.20	0.16	0.08	-0.00	0.22	0.17	0.10
CE	0.20	0.27	0.25	0.63	0.23	0.17	0.18	0.32	0.26	0.17	0.21	0.36
CC	0.21	0.25	0.22	0.32	0.30	0.07	0.23	0.26	0.30	0.07	0.22	0.25
CO	0.50	0.68	0.65	0.66	0.57	0.48	0.69	0.66	0.60	0.57	0.56	0.62
FA	0.69	0.71	0.70	0.78	0.48	0.58	0.66	0.75	0.58	0.39	0.72	0.89
EL	0.71	0.75	0.72	0.79	0.55	0.37	0.57	0.76	0.65	0.37	0.73	0.93
UF	0.35	0.50	0.42	0.64	0.72	0.13	0.34	0.50	0.62	0.12	0.32	0.50
GM	0.59	0.80	0.65	0.82	0.84	0.23	0.55	0.68	0.83	0.22	0.58	0.80
MM	0.45	0.57	0.45	0.83	0.85	0.11	0.35	0.68	0.74	0.07	0.34	0.67
CL	0.73	0.58	0.66	0.41	0.12	0.68	0.72	0.41	0.35	0.91	0.74	0.56
ST	0.73	0.71	0.72	0.60	0.37	0.44	0.57	0.58	0.50	0.44	0.77	0.92
GT	1.00	0.79	0.87	0.51	0.28	0.46	0.20	0.53	0.56	0.49	0.96	0.73
SC	0.79	1.00	0.93	0.73	0.59	0.38	0.75	0.74	0.90	0.38	0.78	0.76
GCT	0.87	0.93	1.00	0.60	0.40	0.43	0.82	0.70	0.63	0.43	0.95	0.76
ARMYEL	0.51	0.73	0.60	1.00	0.78	0.23	0.50	0.77	0.91	0.22	0.53	0.77
AIRM	0.28	0.59	0.40	0.78	1.00	0.06	0.28	0.59	0.35	0.04	0.27	0.55
AIRA	0.46	0.38	0.43	0.23	0.06	1.00	0.46	0.24	0.22	0.91	0.47	0.39
AING	0.90	0.75	0.82	0.50	0.28	0.46	1.00	0.55	0.55	0.46	0.91	0.69
AIRF	0.53	0.74	0.70	0.77	0.59	0.24	0.55	1.00	0.60	0.23	0.56	0.75
NAVM	0.56	0.60	0.63	0.91	0.85	0.22	0.55	0.60	1.00	0.22	0.53	0.64
NAVC	0.49	0.38	0.43	0.22	0.04	0.21	0.46	0.23	0.22	1.00	0.50	0.39
NAVG	0.96	0.78	0.95	0.53	0.27	0.47	0.91	0.56	0.53	0.50	1.00	0.76
NAVE	0.75	0.76	0.73	0.77	0.53	0.39	0.69	0.75	0.64	0.39	0.76	1.00
AGE	0.18	0.12	0.16	0.04	-0.01	0.08	0.16	0.06	0.06	0.11	0.16	0.07
EDUC	0.02	0.01	0.02	0.03	0.00	0.09	0.02	0.04	0.01	0.08	0.02	0.06
RACEH	0.24	0.31	0.26	0.34	0.35	0.17	0.27	0.30	0.37	0.16	0.27	0.33
RACEB	-0.22	-0.29	-0.25	-0.32	-0.39	-0.18	-0.24	-0.29	-0.35	-0.16	-0.24	-0.31
SEX	-0.09	0.02	-0.05	0.24	0.33	-0.20	-0.08	0.14	0.18	-0.24	-0.10	0.05
FCG	0.37	0.43	0.40	0.46	0.28	0.32	0.33	0.40	0.34	0.32	0.39	0.54

TABLE D-1-4 (Cont'd)

	AGE	EDUC	RACEW	RACEB	SEX	FCG
GI	0.05	0.07	0.24	-0.23	0.30	0.22
NO	0.03	0.04	0.13	-0.14	-0.19	0.27
AD	0.03	0.08	0.05	-0.06	-0.17	0.18
MK	0.20	0.03	0.17	-0.15	-0.11	0.23
AR	0.05	0.00	0.27	-0.24	-0.02	0.37
SP	0.04	-0.01	0.14	-0.17	0.01	0.26
MK	0.04	0.06	0.20	-0.22	-0.08	0.45
EI	0.06	0.06	0.23	-0.20	0.27	0.32
MC	-0.00	0.00	0.30	-0.29	0.18	0.34
GS	0.02	0.04	0.25	-0.24	0.02	0.36
SI	-0.02	-0.01	0.37	-0.37	0.31	0.18
AI	0.02	0.00	0.23	-0.29	0.30	0.21
CM	0.02	-0.00	0.16	-0.17	0.21	0.10
CA	0.13	0.00	-0.04	0.01	-0.12	0.10
CE	0.03	0.04	0.05	-0.06	0.08	0.34
CC	-0.00	-0.04	0.22	-0.24	0.11	0.09
CO	0.04	0.01	0.36	-0.37	0.06	0.37
FA	0.11	0.07	0.29	-0.28	0.11	0.50
EL	0.07	0.06	0.32	-0.30	0.08	0.53
OF	0.10	0.03	0.27	-0.29	0.27	0.29
GM	0.04	0.01	0.37	-0.35	0.13	0.43
MM	0.04	0.03	0.35	-0.34	0.29	0.35
CL	0.17	0.06	0.18	-0.18	-0.20	0.35
ST	0.06	0.05	0.29	-0.28	-0.05	0.51
GI	0.18	0.02	0.24	-0.22	-0.05	0.37
SC	0.12	0.01	0.31	-0.29	0.02	0.43
GCT	0.15	0.02	0.26	-0.25	-0.05	0.40
ARMYEL	0.04	0.03	0.34	-0.32	0.24	0.46
AIRM	-0.01	0.00	0.39	-0.39	0.33	0.28
AIRA	0.08	0.08	0.17	-0.18	-0.20	0.32
AIRG	0.14	0.02	0.27	-0.24	-0.08	0.33
AIRE	0.06	0.04	0.30	-0.29	0.14	0.40
NAVM	0.06	0.01	0.37	-0.35	0.18	0.34
NAVC	0.11	0.08	0.16	-0.16	-0.24	0.32
NAVG	0.16	0.02	0.27	-0.24	-0.10	0.39
NAVE	0.07	0.06	0.33	-0.31	0.05	0.54
AGE	1.00	0.13	-0.08	0.09	-0.03	0.09
EDUC	0.13	1.00	-0.06	0.05	-0.00	0.15
RACEW	-0.08	-0.06	1.00	-0.87	0.00	0.14
RACEB	0.09	0.05	-0.87	1.00	0.00	-0.15
SEX	-0.03	-0.00	0.00	0.00	1.00	0.00
FCG	0.09	0.15	0.14	-0.15	0.00	1.00

TABLE D-1-5

BEC CORRECTED MATRIX MEANS AND STANDARD DEVIATIONS

VARIABLE	MEAN	STANDARD DEV
GI	11.47	2.93
NO	36.64	9.81
AD	16.08	4.71
MK	25.39	6.04
AN	16.40	4.16
SP	15.18	3.81
MK	15.76	4.49
EI	23.02	5.47
MC	14.14	3.97
GS	14.62	3.80
SI	15.78	4.03
AI	13.61	4.55
CM	12.64	4.88
CA	10.65	3.17
CE	11.37	4.47
CC	19.21	4.01
CO	118.11	18.94
FA	121.70	16.04
EL	122.06	17.68
OF	115.38	19.32
GM	118.83	17.77
MM	117.57	19.62
CL	120.93	17.80
ST	121.31	17.18
GTX	121.17	16.51
SC	120.16	16.60
GCT	120.30	16.43
ARMYEL	122.77	16.58
AIRM	73.53	25.40
AIRA	73.01	25.15
AIRG	83.49	24.68
AIRE	82.89	25.45
NAVM	172.46	19.68
NAVC	167.25	19.07
NAVG	118.09	14.03
NAVE	236.64	27.99
AGE	19.17	1.31
EDUC	0.89	0.47
RACEW	0.86	0.44
RACEB	0.10	0.41
SEX	0.93	0.19
FCG	80.68	9.80

TABLE D-1-6

BEC CORRECTED CORRELATION[a] MATRIX

	GI	NG	AD	MK	AR	SP	MK	EI	MC	GS	SI	AI
GI	1.00	0.28	0.04	0.54	0.43	0.27	0.42	0.52	0.48	0.54	0.49	0.47
NG	0.28	1.00	0.37	0.30	0.48	0.19	0.52	0.28	0.29	0.32	0.20	0.16
AD	0.04	0.37	1.00	0.10	0.21	0.15	0.23	0.10	0.13	0.11	0.06	0.01
MK	0.54	0.30	0.10	1.00	0.52	0.27	0.49	0.51	0.47	0.65	0.37	0.36
AR	0.43	0.48	0.21	0.52	1.00	0.37	0.67	0.46	0.52	0.53	0.38	0.36
SP	0.27	0.19	0.15	0.27	0.37	1.00	0.36	0.38	0.51	0.33	0.34	0.30
MK	0.42	0.52	0.23	0.45	0.67	0.36	1.00	0.46	0.50	0.54	0.32	0.29
EI	0.52	0.28	0.10	0.51	0.46	0.38	0.46	1.00	0.60	0.60	0.60	0.55
MC	0.48	0.29	0.13	0.47	0.52	0.51	0.50	0.60	1.00	0.59	0.59	0.55
GS	0.54	0.32	0.11	0.65	0.53	0.33	0.54	0.60	0.59	1.00	0.50	0.46
SI	0.49	0.20	0.06	0.37	0.38	0.34	0.32	0.60	0.59	0.50	1.00	0.65
AI	0.47	0.16	0.01	0.36	0.36	0.30	0.29	0.55	0.55	0.46	0.65	1.00
CM	0.15	0.02	0.00	0.02	0.10	0.16	0.03	0.30	0.27	0.12	0.38	0.46
CA	0.05	0.20	0.13	0.17	0.18	0.04	0.21	0.09	0.04	0.14	-0.03	-0.02
CE	0.11	0.19	0.11	0.14	0.25	0.18	0.29	0.25	0.21	0.21	0.11	0.11
CC	0.36	0.20	0.09	0.31	0.28	0.20	0.24	0.33	0.35	0.33	0.37	0.31
CO	0.50	0.47	0.52	0.45	0.70	0.63	0.57	0.58	0.65	0.56	0.67	0.50
FA	0.67	0.51	0.21	0.63	0.78	0.42	0.77	0.78	0.63	0.68	0.53	0.51
EL	0.59	0.49	0.20	0.65	0.75	0.44	0.79	0.81	0.67	0.79	0.57	0.53
OF	0.72	0.31	0.08	0.51	0.48	0.31	0.44	0.62	0.55	0.57	0.59	0.80
GM	0.60	0.40	0.15	0.61	0.75	0.46	0.61	0.70	0.82	0.79	0.67	0.76
MM	0.56	0.33	0.12	0.47	0.53	0.42	0.57	0.82	0.68	0.60	0.79	0.61
CL	0.46	0.52	0.55	0.77	0.73	0.33	0.62	0.49	0.48	0.59	0.34	0.30
ST	0.54	0.53	0.22	0.63	0.65	0.41	0.85	0.55	0.61	0.79	0.47	0.43
GT	0.56	0.43	0.17	0.56	0.60	0.35	0.63	0.55	0.55	0.68	0.43	0.40
SC	0.57	0.42	0.19	0.66	0.77	0.45	0.64	0.62	0.78	0.69	0.54	0.50
GCT	0.55	0.42	0.19	0.64	0.78	0.64	0.64	0.58	0.63	0.67	0.47	0.43
ARMYEL	0.56	0.40	0.17	0.56	0.71	0.48	0.61	0.83	0.79	0.67	0.74	0.63
AIRV	0.56	0.25	0.08	0.46	0.48	0.42	0.42	0.65	0.83	0.59	0.87	0.86
AIRA	0.41	0.87	0.57	0.61	0.56	0.27	0.60	0.41	0.41	0.49	0.30	0.25
AIRG	0.56	0.42	0.16	0.91	0.60	0.35	0.62	0.55	0.55	0.67	0.43	0.41
AIRE	0.53	0.41	0.19	0.55	0.75	0.65	0.62	0.83	0.69	0.62	0.58	0.55
NAVV	0.62	0.32	0.12	0.75	0.56	0.46	0.53	0.70	0.85	0.71	0.81	0.64
NAVC	0.36	0.76	0.75	0.55	0.54	0.27	0.55	0.38	0.39	0.47	0.28	0.21
NAVG	0.55	0.45	0.18	0.65	0.67	0.36	0.66	0.55	0.56	0.67	0.43	0.40
NAVE	0.58	0.49	0.21	0.66	0.81	0.44	0.82	0.77	0.68	0.82	0.55	0.52
AGE	-0.03	-0.01	0.03	0.09	0.08	-0.04	-0.02	0.00	-0.06	0.00	-0.06	0.01
EDUC	0.11	0.15	0.07	0.05	0.11	0.01	0.20	0.05	0.07	0.15	0.02	0.03
RACEb	0.37	0.20	0.03	0.25	0.23	0.15	0.26	0.33	0.38	0.32	0.45	0.40
RACEa	-0.35	-0.21	-0.04	-0.25	-0.38	-0.22	-0.25	-0.32	-0.37	-0.30	-0.44	-0.35
SEX	0.16	-0.17	-0.15	-0.37	-0.12	-0.06	-0.14	0.03	0.02	-0.10	0.16	0.12
FCG	0.37	0.41	0.25	0.41	0.54	0.35	0.60	0.49	0.48	0.52	0.31	0.34

TABLE D-1-6 (Cont'd)

	CM	CA	CE	CC	CO	FA	EL	OF	GM	MM	CL	ST
GI	0.15	0.05	0.11	0.26	0.50	0.67	0.59	0.72	0.60	0.56	0.46	0.54
NO	0.02	0.20	0.19	0.28	0.47	0.51	0.49	0.31	0.40	0.33	0.52	0.53
AD	0.00	0.13	0.11	0.05	0.52	0.21	0.20	0.08	0.15	0.12	0.55	0.22
AK	0.02	0.17	0.14	0.31	0.46	0.63	0.65	0.51	0.61	0.47	0.77	0.63
AR	0.18	0.18	0.25	0.28	0.70	0.76	0.79	0.46	0.75	0.53	0.73	0.85
SP	0.16	0.04	0.18	0.26	0.43	0.42	0.44	0.31	0.46	0.42	0.33	0.41
HK	0.03	0.21	0.29	0.24	0.57	0.75	0.79	0.44	0.61	0.57	0.62	0.85
EI	0.30	0.09	0.25	0.33	0.56	0.78	0.81	0.62	0.70	0.82	0.49	0.59
MS	0.27	0.04	0.21	0.35	0.65	0.63	0.67	0.55	0.82	0.68	0.48	0.61
GS	0.12	0.14	0.21	0.33	0.56	0.66	0.79	0.53	0.79	0.60	0.59	0.75
SI	0.38	-0.03	0.11	0.37	0.67	0.53	0.57	0.55	0.67	0.79	0.34	0.47
AI	0.46	-0.02	0.11	0.31	0.50	0.51	0.53	0.80	0.76	0.81	0.30	0.43
CM	1.00	0.10	0.39	0.34	0.30	0.21	0.19	0.39	0.31	0.60	0.08	0.10
CA	0.10	1.00	0.43	0.10	0.14	0.38	0.19	0.44	0.10	0.10	0.47	0.21
CE	0.39	0.43	1.00	0.18	0.28	0.38	0.30	0.30	0.23	0.32	0.31	0.28
CC	0.34	0.10	0.18	1.00	0.61	0.38	0.37	0.39	0.41	0.44	0.32	0.34
CO	0.30	0.14	0.26	0.61	1.00	0.73	0.74	0.58	0.76	0.72	0.74	0.72
FA	0.21	0.38	0.36	0.38	0.73	1.00	0.94	0.76	0.82	0.78	0.78	0.85
EL	0.19	0.19	0.30	0.37	0.74	0.94	1.00	0.66	0.88	0.80	0.73	0.94
OF	0.39	0.44	0.30	0.35	0.58	0.78	0.66	1.00	0.76	0.78	0.58	0.58
GM	0.31	0.10	0.23	0.41	0.76	0.82	0.88	0.76	1.00	0.83	0.66	0.84
MM	0.60	0.10	0.32	0.44	0.72	0.78	0.80	0.78	0.83	1.00	0.50	0.67
CL	0.08	0.47	0.31	0.32	0.74	0.78	0.73	0.58	0.66	0.50	1.00	0.75
ST	0.10	0.21	0.28	0.34	0.72	0.85	0.94	0.58	0.84	0.67	0.75	1.00
GT	0.06	0.20	0.21	0.34	0.65	0.78	0.80	0.57	0.76	0.57	0.86	0.82
SC	0.16	0.15	0.24	0.28	0.79	0.80	0.83	0.61	0.85	0.68	0.79	0.81
GCT	0.11	0.18	0.23	0.35	0.76	0.79	0.81	0.57	0.78	0.61	0.82	0.81
ARMYEL	0.40	0.20	0.50	0.42	0.75	0.87	0.88	0.71	0.88	0.88	0.65	0.77
AIR1	0.43	-0.01	0.15	0.40	0.70	0.64	0.68	0.76	0.87	0.88	0.43	0.56
AIR2	0.02	0.23	0.21	0.28	0.65	0.64	0.63	0.43	0.54	0.43	0.60	0.65
AIR3	0.06	0.19	0.19	0.34	0.65	0.78	0.79	0.57	0.75	0.56	0.85	0.81
AIR4	0.25	0.13	0.27	0.35	0.80	0.85	0.88	0.61	0.82	0.78	0.65	0.78
NAV1	0.28	0.07	0.19	0.42	0.74	0.73	0.77	0.68	0.87	0.80	0.65	0.70
NAV2	0.01	0.23	0.20	0.27	0.65	0.55	0.59	0.39	0.51	0.40	0.85	0.61
NAV3	0.06	0.20	0.22	0.24	0.66	0.81	0.82	0.56	0.78	0.57	0.86	0.85
NAV4	0.17	0.19	0.31	0.26	0.74	0.93	0.98	0.64	0.88	0.77	0.74	0.95
AGE	-0.01	0.15	0.10	-0.07	-0.03	0.01	-0.01	0.06	-0.01	-0.02	0.08	-0.01
EDUC	-0.05	0.11	0.07	-0.06	0.07	0.17	0.15	0.11	0.10	0.08	0.14	0.17
RACE#	0.15	-0.11	-0.05	0.32	0.41	0.35	0.39	0.35	0.46	0.44	0.24	0.35
RACE#	-0.17	0.13	0.05	-0.21	-0.41	-0.33	-0.37	-0.33	-0.44	-0.43	-0.21	-0.33
SEX	0.15	-0.16	0.03	0.02	-0.05	-0.08	-0.09	0.04	-0.02	0.08	-0.22	-0.14
FCG	0.11	0.17	0.14	0.26	0.49	0.60	0.61	0.42	0.54	0.49	0.49	0.59

TABLE D-1-6 (Cont'd)

	GT	SC	GCT	ARMYEL	AIRM	AIRA	AIRG	AIRE	NAVM	NAVC	NAVG	NAVE
GI	0.56	0.57	0.55	0.56	0.56	0.41	0.56	0.53	0.62	0.36	0.55	0.58
MD	0.43	0.42	0.42	0.40	0.25	0.87	0.42	0.41	0.32	0.76	0.45	0.49
AD	0.17	0.17	0.17	0.17	0.08	0.57	0.16	0.17	0.12	0.75	0.18	0.21
MK	0.90	0.30	0.84	0.56	0.46	0.61	0.91	0.55	0.75	0.59	0.95	0.66
AR	0.80	0.77	0.78	0.71	0.48	0.58	0.80	0.75	0.58	0.54	0.87	0.81
SP	0.35	0.65	0.64	0.48	0.43	0.27	0.35	0.69	0.46	0.27	0.36	0.44
MK	0.63	0.64	0.64	0.41	0.42	0.60	0.62	0.62	0.53	0.55	0.66	0.82
EI	0.55	0.63	0.58	0.83	0.69	0.41	0.55	0.83	0.70	0.38	0.55	0.77
MC	0.55	0.78	0.63	0.79	0.81	0.41	0.55	0.69	0.85	0.39	0.56	0.68
GS	0.64	0.69	0.67	0.67	0.59	0.45	0.67	0.62	0.71	0.47	0.67	0.82
SI	0.43	0.54	0.47	0.74	0.97	0.30	0.43	0.58	0.81	0.28	0.43	0.55
AI	0.40	0.50	0.43	0.63	0.86	0.25	0.41	0.55	0.64	0.21	0.40	0.52
CM	0.06	0.16	0.11	0.43	0.43	0.02	0.06	0.25	0.28	0.01	0.06	0.17
CA	0.20	0.15	0.18	0.20	-0.01	0.23	0.19	0.13	0.07	0.23	0.20	0.19
CE	0.21	0.24	0.23	0.50	0.15	0.21	0.19	0.27	0.19	0.20	0.22	0.31
CC	0.34	0.38	0.35	0.42	0.40	0.28	0.34	0.35	0.42	0.27	0.34	0.36
CO	0.65	0.79	0.[illegible]	0.79	[illegible]0	0.65	0.65	0.80	0.74	0.69	0.61	0.74
FA	0.78	0.80	0.[illegible]	0.87	0.64	0.64	0.78	0.85	0.73	0.59	0.81	0.93
EL	0.80	0.83	0.81	0.88	0.68	0.63	0.79	0.88	0.77	0.59	0.82	0.90
OF	0.57	0.61	0.57	0.71	0.76	0.43	0.57	0.61	0.68	0.39	0.56	0.64
GM	0.76	0.85	0.79	0.83	0.87	0.54	0.75	0.82	0.87	0.51	0.78	0.88
MM	0.57	0.68	0.61	0.83	0.88	0.43	0.56	0.78	0.80	0.40	0.57	0.77
CL	0.86	0.79	0.82	0.65	0.43	0.80	0.85	0.65	0.65	0.35	0.86	0.74
ST	0.82	0.81	0.81	0.77	0.59	0.65	0.81	0.78	0.70	0.61	0.85	0.95
GT	1.00	0.90	0.93	0.70	0.53	0.68	0.97	0.71	0.77	0.65	0.98	0.91
SC	0.90	1.00	0.97	0.81	0.69	0.64	0.89	0.95	0.87	0.61	0.89	0.84
GCT	0.93	0.97	1.00	0.74	0.58	0.65	0.92	0.83	0.79	0.63	0.92	0.82
ARMYEL	0.70	0.81	0.74	1.00	0.93	0.53	0.69	0.87	0.86	0.50	0.72	0.86
AIRM	0.53	0.69	0.58	0.83	1.00	0.37	0.53	0.70	0.87	0.34	0.53	0.67
AIRA	0.68	0.64	0.65	0.53	0.37	1.00	0.63	0.54	0.56	0.94	0.68	0.64
AIRG	0.97	0.89	0.92	0.69	0.53	0.68	1.00	0.72	0.77	0.64	0.97	0.81
AIRE	0.71	0.85	0.83	0.87	0.70	0.54	0.72	1.00	0.75	0.50	0.74	0.86
NAVM	0.77	0.87	0.77	0.86	0.87	0.54	0.77	0.75	1.00	0.52	0.76	0.78
NAVC	0.65	0.61	0.63	0.50	0.34	0.94	0.64	0.50	0.52	1.00	0.65	0.60
NAVG	0.98	0.89	0.92	0.72	0.53	0.68	0.97	0.74	0.76	0.65	1.00	0.84
NAVE	0.81	0.84	0.82	0.86	0.67	0.64	0.81	0.86	0.78	0.60	0.84	1.00
AGE	0.05	0.00	0.03	-0.00	-0.05	0.02	0.03	-0.01	-0.01	0.04	[illegible].04	-0.00
EDUC	0.10	0.09	0.09	0.10	0.04	0.16	0.10	0.09	0.08	0.15	0.11	0.17
RACEN	0.35	0.39	0.35	0.40	0.42	0.26	0.36	0.38	0.46	0.22	0.35	0.38
RACEB	-0.31	-0.37	-0.33	-0.38	-0.48	-0.25	-0.32	-0.38	-0.43	-0.21	-0.31	-0.36
SEX	-0.16	-0.11	-0.15	0.03	0.12	-0.21	-0.16	-0.06	0.00	-0.23	-0.17	-0.10
FCG	0.58	0.56	0.55	0.57	0.39	0.46	0.39	0.40	0.53	0.50	0.60	0.66

TABLE D-1-6 (Cont'd)

	AGE	EDUC	RACEW	RACEB	SEX	FCG
GI	-0.03	0.11	0.37	-0.35	0.10	0.37
NO	-0.01	0.15	0.20	-0.21	-0.17	0.41
AO	0.03	0.07	0.03	-0.04	-0.15	0.23
MK	0.07	0.09	0.29	-0.25	-0.17	0.41
AR	0.00	0.11	0.33	-0.30	-0.12	0.54
SP	-0.02	0.03	0.19	-0.22	-0.06	0.35
MK	-0.02	0.20	0.26	-0.25	-0.14	0.60
EI	0.00	0.09	0.33	-0.32	0.03	0.49
MC	-0.06	0.07	0.38	-0.37	0.02	0.48
GS	0.00	0.15	0.32	-0.30	-0.10	0.52
SI	-0.06	0.02	0.45	-0.44	0.16	0.31
AI	0.01	0.03	0.40	-0.39	0.12	0.34
CM	-0.01	-0.05	0.15	-0.17	0.15	0.11
CA	0.15	0.11	-0.11	0.13	-0.15	0.17
CE	0.10	0.07	-0.05	0.05	0.03	0.34
CC	-0.07	-0.00	0.32	-0.31	0.03	0.20
CO	-0.03	0.07	0.41	-0.41	-0.05	0.49
FA	0.01	0.17	0.35	-0.33	-0.08	0.60
EL	-0.01	0.15	0.39	-0.37	-0.09	0.61
OF	0.06	0.11	0.35	-0.33	0.04	0.42
GM	-0.01	0.10	0.46	-0.44	-0.02	0.54
MM	-0.02	0.08	0.44	-0.43	0.08	0.49
CL	0.08	0.14	0.24	-0.21	-0.22	0.49
ST	-0.01	0.17	0.35	-0.33	-0.14	0.59
GT	0.05	0.10	0.35	-0.31	-0.16	0.58
SC	0.00	0.09	0.39	-0.37	-0.11	0.56
GCT	0.03	0.07	0.35	-0.33	-0.15	0.55
ARMYEL	-0.00	0.10	0.40	-0.38	0.03	0.57
AIRM	-0.05	0.04	0.49	-0.48	0.12	0.39
AIRA	0.02	0.16	0.26	-0.25	-0.21	0.46
AIRG	0.03	0.10	0.36	-0.32	-0.16	0.39
AIRE	-0.01	0.09	0.38	-0.38	-0.06	0.40
NAVM	-0.01	0.08	0.46	-0.43	0.00	0.53
NAVC	0.04	0.15	0.22	-0.21	-0.23	0.50
NAVG	0.04	0.11	0.35	-0.31	-0.17	0.60
NAVE	-0.00	0.17	0.38	-0.36	-0.10	0.66
AGE	1.00	0.17	-0.13	0.13	-0.10	0.17
EDUC	0.17	1.00	-0.07	0.06	-0.09	0.10
RACEW	-0.13	-0.07	1.00	-0.87	-0.04	0.25
RACEB	0.13	0.06	-0.87	1.00	0.03	-0.24
SEX	-0.10	-0.09	-0.04	0.03	1.00	-0.00
FCG	0.17	0.10	0.25	-0.24	-0.00	1.00

APPENDIX E

STATISTICAL UNCERTAINTY OF CORRELATION COEFFICIENTS

APPENDIX E

STATISTICAL UNCERTAINTY OF CORRELATION COEFFICIENTS

Estimates of the statistical uncertainty in correlation coefficients as a function of sample size and magnitude of the correlation coefficient are taken from [E-1] and shown in figure E-1.

Families of curves, one for each range of correlation coefficients, are shown in figure E-1. Each curve shows the statistical uncertainty in the correlation coefficient as a function of sample size. For example, the lower curve (appropriate for use with correlation coefficients of approximately 0.9) indicates that we should expect a statistical error of 0.03 in a 0.90 correlation coefficient obtained from a sample of 40 cases.

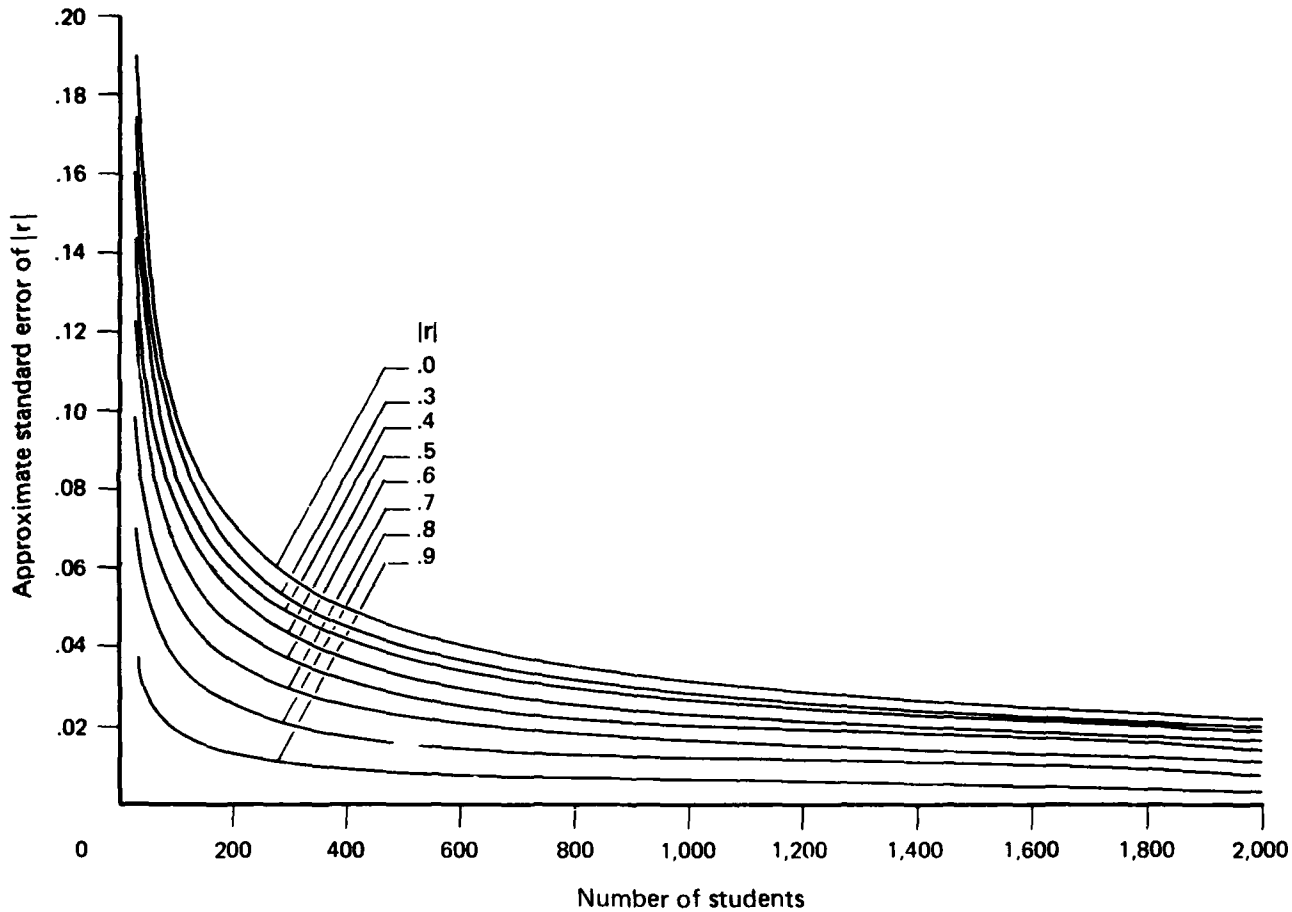

FIG. E-1: RELATIONSHIP BETWEEN SCHOOL SIZE, MAGNITUDE OF CORRELATION (|r|), AND STATISTICAL UNCERTAINTY

REFERENCES

[E-1] CNA, Study 1084, "An Analysis of Marine Corps School Assignment and Performance," Steve Verna and Thomas L. Mifflin, Unclassified Jan 1977

APPENDIX F

EFFECT OF EDUCATION, RACE, AND SEX ON COURSE PERFORMANCE

APPENDIX F

EFFECT OF EDUCATION, RACE, AND SEX ON COURSE PERFORMANCE

To determine if educational level, race, or sex had any effect on course performance (after controlling for ASVAB scores) the following regression equation* was estimated for each course:

$$FCG = A + B\,(ASVAB) + C\,(EDUC) + D\,(RACE) + E\,(SEX) \qquad (F\text{-}1)$$

where:

ASVAB = ASVAB composite score recommended for this course
EDUC = 1 for high school graduates, 0 otherwise
RACE = 1 for whites, 0 otherwise
SEX = 1 for males, 0 otherwise
A,B,C,D,E = constants to be estimated
FCG = final course grade.

For those dichotomous variables found to be significant the size of the effect was expressed as the number of composite score points that were equivalent to the effect.

RESULTS OF REGRESSION ANALYSIS

Results are shown in table F-1. For example, in the Administrative Clerk's Course, the final course grade of a high school graduate will be the same as that of a nongraduate with a CL score 19.0 points higher.** The grade of a Caucasian will be the same as that of a non-Caucasian with a CL score about 11.9 points higher and a male's grade will be equal to that of a female's, with a composite score 8.0 points lower.

The data of table F-1 are summarized in table F-2. To minimize misinterpretations due to small sample size only results from courses containing at least 100 cases for each value of each dichotomous

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* The regression analysis was conducted on data uncorrected for range restriction. This procedure was possible because only one ASVAB score was being used in each regression. The procedure was desirable because, as noted in appendix D, range correction is very unreliable for dichotomous variables such as those in equation F-1.

** For example, the regression equation for this course is:
FCG = 57.7 + 0.19(ASVAB) + 3.61(EDUC) + 2.27(RACE) - 1.52(SEX).
Therefore the number of ASVAB composite points that would be equivalent to the effect of the EDUC variable is $\frac{3.61}{0.19} = 19.0$.

TABLE F-1

EFFECT OF EDUCATION, RACE, AND SEX ON PERFORMANCE IN MILITARY COURSES

Course	Sample size	Regression parameter ASVAB (B)	Regression parameter Educ (C)	Regression parameter Race (D)	Regression parameter Sex (E)	Equivalent composite score points Educ	Equivalent composite score points Race	Equivalent composite score points Sex	Number in sample Non-Cauc	Number in sample NHSG	Number in sample Female
Basic supply stock clerk	997	0.21	3.36	1.29	—	16.0	6.1	—	229	269	110
Personal financial records clerk	347	0.24	3.24	3.94	—	13.5	16.4	—	45	108	66
Basic automotive mechanic	1,264	0.25	2.14	1.47	—	8.6	5.9	—	354	303	63
Advanced automotive mechanic	610	0.36	1.66	—	—	4.6	—	—	323	134	10
Basic baker	158	0.11	2.37	2.07	—	21.5	18.8	—	88	40	14
Basic food service	578	0.09	2.18	3.10	—	24.2	34.4	—	289	173	75
Basic combat engineer	927	0.24	2.04	1.18	—	8.5	4.9	—	299	260	0
Basic electrician	224	0.21	—	—	—	—	—	—	47	67	11
Electrical equipment repairman	213	0.17	2.91	—	—	17.1	—	—	70	34	9
Basic engineer equipment mechanic	688	0.20	1.54	—	—	7.7	—	—	213	179	14
Administrative clerk	1,325	0.19	3.61	2.27	-1.52	19.0	11.9	-8.0	278	451	464
Personnel clerk	176	0.18	—	—	—	—	—	—	37	69	48
Unit diary clerk	148	0.22	3.54	—	—	16.1	—	—	36	47	52
Sea duty indoctrination	537	0.10	3.04	—	—	30.4	—	—	252	140	0
Basic electronics	992	0.42	3.39	—	—	8.1	—	—	99	127	60
Radio fundamentals	157	0.19	—	—	—	—	—	—	14	16	9
Field radio operator	1,217	0.17	1.49	—	-1.37	8.8	—	-8.1	511	316	85
Communications center man	679	0.23	3.86	1.60	—	16.8	7.0	—	224	224	81
Infantry training	4,117	0.12	1.77	—	—	14.8	—	—	1,112	1,235	0
Tracked vehicle repair	233	0.23	1.83	—	—	8.0	—	—	75	26	0
Basic helicopter	789	0.26	2.77	—	—	10.7	—	—	252	103	0
Aviation structural mechanic (safety equipment)	123	0.19	—	—	—	—	—	—	42	9	0
Aviation structural mechanic (hydraulics)	551	0.33	3.25	—	—	9.8	—	—	182	66	6
Aviation structural mechanic (structures)	592	0.20	3.43	—	-4.0[a]	17.2	—	-20.1[a]	225	53	6
Aviation ordnance	283	0.13	2.15	—	—	16.5	—	—	62	28	0
Aviation crash crew	294	0.12	—	2.59	—	—	21.6	—	106	68	0
Avionics repair	290	0.23	1.65[a]	—	—	7.2[a]	—	—	38	20	0
Aviation operations (clerical)	247	0.09	2.54	1.53[a]	-2.55	28.2	17.0[a]	-28.3	54	62	44
Aviation maintenance administration	214	0.20	3.58	—	—	17.9	—	—	49	60	39
Aviation supply (mechanical)	494	0.23	3.01	2.45	—	13.1	10.7	—	138	163	49
Small arms repair	323	0.13	1.34	—	—	10.3	—	—	90	81	36
Ammunition storage	306	0.14	2.08	—	—	14.9	—	—	83	83	0
Basic cannoneer	163	0.13	—	—	—	—	—	—	23	90	0

[a]These variables enter at the 95 percent confidence level, all others enter at the 99 percent level.

variable (education, race, and sex) were summarized. The results in table F-2 indicate that the effect of educational level on validity is consistent across a wide spectrum of courses. On average, high school graduates perform in training like non-high school graduates with composite scores about 13 points higher. Because of the size and consistency of the effect we recommend compensating actions be taken.

With respect to race, the situation is less clear. In 8 of the 15 courses examined, the minority recruits did not perform as well in training as other recruits with the same composite scores. However, the effect is small and is not consistent across all courses. On average, the ASVAB overpredicts minority performance by about 6 composite points. In any event, the data are conclusive that the ASVAB is not biased against minorities. If any bias exists, it appears to be in favor of minorities. Because the effect is small and not consistent over all courses we recommend that no compensating actions be taken.

TABLE F-2

SUMMARY OF EFFECT OF CIVILIAN EDUCATION, RACE, AND SEX ON COURSE PERFORMANCE

Variable	Number of courses[a]	Number of courses in which variable was significant[b]	Mean equivalent composite score points[c,d] underprediction	Group for which performance is underpredicted
Education	16	15	13	Graduates
Race	15	8	6	Whites
Sex	2	1	4	Females

[a]Courses in which each dichotomous subgroup contained 100 or more cases.
[b]Significant at the 99 percent confidence level.
[c]Number of composite score points to which membership in the better performing dichotomy is equivalent.
[d]In computing the mean, courses for which the variable were not statistically significant were assigned zero equivalent score points.

With regard to females, the availability of sufficient cases precluded general conclusions. There were only two courses with 100 or more females. In one of these courses sex did seem to make a difference in predicting training performance. Here, as is the case for race, the effect is small and not consistent for all courses. On average, the ASVAB seems to underpredict the performance of females by about 4

composite score points. Due to the small size and lack of consistency of the effect, we recommend that no compensating actions be taken.

RAW DATA DISTRIBUTIONS

To rule out the possibility that the effects of education, race, and sex on performance are induced by the regression procedure we examined raw data distributions. The Administrative Clerk and Basic Auto Mechanics courses were selected for this examination because of their representative nature and large sample size. Mean final course grade was tabulated for ASVAB composite scores in 10-point intervals (CL for Administrative Clerk and GM for Basic Auto Mechanics). The data were then further broken out by educational, racial, and sex groups in table F-3, F-4, and F-5. These tables show the same types of differences that emerged from the regression analyses. Therefore, we conclude that the results of the regression analysis with respect to differential prediction of population subgroups represent real effects and are not induced by the regression procedure.

TABLE F-3

MEAN FINAL COURSE GRADE BY APTITUDE SCORE INTERVAL BY EDUCATION

Course	Aptitude score interval	Mean final course grade: High school graduate	Mean final course grade: Non-high school graduate
Administrative clerk	90-99	78.8	-[a]
	100-109	81.3	77.7
	110-119	83.2	79.4
	120-129	85.9	81.2
Basic auto mechanic	90-99	81.3	78.9
	100-109	84.2	82.1
	110-119	87.2	85.6
	120-129	89.6	87.0

[a]This interval contains too few recruits to reflect statistically sound results.

TABLE F-4

MEAN FINAL COURSE GRADE BY APTITUDE
SCORE INTERVAL BY RACE

Course	Aptitude score interval	Mean final course grade	
		Caucasian	Non-caucasian
Administrative clerk	90-99	80.6	76.9
	100-109	81.4	79.6
	110-119	83.0	80.9
	120-129	85.3	83.1
Basic auto mechanic	90-99	81.2	79.8
	100-109	83.6	83.1
	110-119	87.0	85.5
	120-129	89.1	-[a]

[a]This interval contains too few recruits to reflect statistically sound results.

TABLE F-5

MEAN FINAL COURSE GRADE BY APTITUDE
SCORE INTERVAL BY SEX

Course[a]	Aptitude score interval	Mean final course grade	
		Female high school graduate	Male high school graduate
Administrative clerk	90-99	-[b]	78.7
	100-109	83.6	80.1
	110-119	84.7	82.4
	120-129	86.2	85.6

[a]There were too few females in the Basic Auto Mechanics Course to allow the display of data.
[b]This interval contains too few recruits to reflect statistically sound results.

APPENDIX G

PERFORMANCE AS A FUNCTION OF APTITUDE COMPOSITE SCORE

APPENDIX G

PERFORMANCE AS A FUNCTION OF APTITUDE COMPOSITE SCORE

In this appendix we tabulate CY 1977-78 performance data by aptitude composite interval for the 46 courses for which such information was available. We also tabulate FY 1980 course failure rates for 86 courses.

Table G-1 shows mean final course grade by aptitude composite interval.* The aptitude composites used are those that were found to be most appropriate for each course. All composite scores are expressed in terms of correct ASVAB 6/7 norms.

Table G-2 shows the percentage of recruits in each composite score interval* that fail the indicated course. Table G-3 shows the failure rate expected for the class as a whole if only recruits at or above the indicated cut score were allowed to enter the course.

Table G-4 shows the FY 1980 course failure rates for 86 courses.

* No entries are shown in tables G-1 or G-2 for composite intervals containing less than 20 individuals because the data were judged to be statistically unreliable.

TABLE G-1

MEAN FINAL COURSE GRADE BY SCORE INTERVAL

Course	Selector composite	Score on selector composite							
		60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139
Basic supply stock clerk	CL	—	77.5	76.8	79.2	80.0	82.4	86.4	90.2
Personal financial records clerk	CL	—	—	—	—	80.8	83.4	86.8	91.7
Basic automotive mechanic	GM	—	76.8	78.8	81.6	84.8	87.9	90.1	—
Advanced automotive mechanic	GM	—	75.4	76.6	79.4	82.6	86.7	91.1	—
Basic baker	GT	—	—	—	87.2	87.5	90.4	—	—
Basic food service	GT	—	81.6	81.8	82.5	84.2	85.3	90.4	—
Basic combat engineer	GM	77.5	78.1	79.7	83.5	85.0	88.8	91.6	—
Basic electrician	EL	—	—	—	88.2	88.5	91.5	92.0	—
Electrical equipment repairman	EL	—	—	—	—	80.1	82.6	84.9	—
Basic engineer equipment mechanic	GM	82.3	82.3	84.7	87.0	88.0	91.4	—	—
Administrative clerk	CL	73.4	77.8	78.8	79.4	81.3	83.9	87.8	90.0
Personnel clerk	CL	—	—	—	86.1	88.6	90.8	92.4	—
Unit diary clerk	CL	—	—	—	77.0	82.2	83.5	86.3	—
Sea duty indoctrination	CO	—	80.8	81.1	81.5	83.0	84.3	85.6	—
Basic electronics	EL	—	—	—	71.9	74.2	79.1	84.7	89.0
Radio fundamentals	EL	—	—	—	—	—	81.3	82.5	—
Field radio operator	EL	—	84.3	84.3	85.5	87.1	89.9	91.3	—
Communications center man	CL	—	—	78.9	79.2	81.8	85.0	87.4	91.4
Air control electronic operator	GT	—	—	—	—	81.3	80.7	—	—
Infantry training	CO	80.6	81.5	82.8	83.8	84.7	86.9	87.9	90.3
Tracked vehicle repair	GM	—	—	82.0	83.6	85.1	87.3	—	—
Basic helicopter	GM	—	—	74.7	76.5	79.7	81.7	85.4	—
Aviation structural mechanic (safety equipment)	GM	—	—	—	—	75.8	78.6	79.4	—
Aviation structural mechanic (hydraulics)	GM	—	—	72.9	75.7	78.4	81.8	85.5	—
Aviation structural mechanic (structures)	GM	—	—	73.2	75.5	76.5	78.7	82.4	—
Aviation ordnance	GT	—	—	—	—	81.1	82.3	84.5	—
Aviation crash crew	GM	—	80.3	82.6	83.6	85.6	86.9	—	—
Avionics repair	EL	—	—	—	—	73.5	75.8	78.1	—
Air controlman	GT	—	—	—	—	—	86.0	86.9	—
Air control maintenance[a]	EL	—	—	—	—	—	—	—	—
Aircraft launch & recovery	GM	—	—	—	76.3	79.7	81.3	—	—
Air crew survival equipment	GM	—	—	—	—	—	—	—	—
Aviation operations (clerical)[b]	CL	—	—	84.8	85.4	87.2	88.2	89.7	—
Aviation maintenance administration	CL	—	—	—	73.8	77.1	78.8	83.1	—
Aviation supply (mechanical)	CL	76.8	75.1	77.5	79.7	82.7	84.5	88.8	90.6
Aerographers mate	GT	—	—	—	—	83.8	86.3	85.1	—
Small arms repair	GM	—	85.8	86.4	88.1	89.5	91.5	93.0	—
Tank crewman[c]	FA	—	—	—	—	—	—	—	—
Field artillery fire control	FA	—	86.0	85.1	84.4	88.4	89.9	94.1	—

TABLE G-1 (Cont'd)

Course	Selector composite	Score on selector composite							
		60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139
Ammunition storage	GT	--	--	85.0	84.7	87.2	88.2	--	--
Corrections specialist	GT	--	--	--	--	--	--	--	--
Military police	GT	--	--	--	--	--	--	--	--
Basic cannoneer	FA	--	88.8	87.0	88.8	91.8	92.9	--	--
Basic electricity and electronics	EL	--	--	--	--	--	--	--	--
Aviation machinists mate	GM	--	--	--	--	--	--	--	--
Avionics	EL	--	--	--	--	--	--	--	--

[a]This course is based on pass/fail, therefore no final course grade was reported.
[b]This course is based on time to complete, therefore no final course grade was reported.

TABLE G-2

PERCENTAGE FAILING BY SCORE INTERVAL

Course	Selector composite	Score on selector composite							
		60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139
Basic supply stock clerk	CL	—	60.7	25.6	29.6	24.1	13.7	4.0	2.3
Personal financial records clerk	CL	--	--	--	--	12.8	12.0	1.1	0.0
Basic automotive mechanic	GM	—	10.2	9.5	3.9	3.1	2.7	1.0	—
Advanced automotive mechanic	GM	--	23.8	18.2	11.3	10.6	10.1	4.0	--
Basic baker	GT	—	--	—	13.9	4.1	2.2	--	--
Basic food service	GT	--	0.0	6.5	3.4	7.1	4.1	0.0	--
Basic combat engineer	GM	2.5	2.0	0.5	0.5	0.6	0.0	0.0	--
Basic electrician	EL	--	--	--	0.0	1.1	0.0	0.0	--
Electrical equipment repairman	EL	--	--	--	—	0.0	0.0	0.0	--
Basic engineer equipment mechanic	GM	13.6	6.4	1.1	3.1	6.3	3.0	—	--
Administrative clerk	CL	51.7	31.9	13.2	11.0	10.6	4.2	3.1	2.5
Personnel clerk	CL	--	--	--	0.0	5.6	7.6	0.0	--
Unit diary clerk	CL	--	--	—	18.8	7.3	9.8	2.4	--
Sea duty indoctrination	CO	—	19.1	19.9	14.4	13.9	11.8	6.5	--
Basic electronics	EL	--	--	—	83.1	61.8	34.4	12.3	0.0
Radio fundamentals	EL	--	--	--	--	--	9.0	4.0	—
Field radio operator	EL	—	2.1	10.1	6.3	0.9	1.1	1.6	--
Communications center man	CL	--	--	24.1	22.5	19.1	6.1	3.7	0.0
Air control electronic operator	GT	—	--	--	—	11.4	13.6	—	—
Infantry training	CO	0.0	0.3	0.3	0.9	0.7	0.0	0.5	0.0
Tracked vehicle repair	GM	--	—	17.7	5.6	9.4	5.5	—	--
Basic helicopter	GM	--	--	2.1	4.3	1.0	1.5	1.0	--
Aviation structural mechanic (safety equipment)	GM	--	--	--	—	2.4	0.0	0.0	--
Aviation structural mechanic (hydraulics)	GM	--	--	5.3	4.9	0.9	0.0	2.8	--
Aviation structural mechanic (structures)	GM	—	—	7.1	5.2	2.7	1.3	0.0	--
Aviation ordnance	GT	--	--	--	--	0.0	1.3	0.0	--
Aviation crash crew	GM	--	3.6	0.0	0.0	0.0	0.0	--	--
Avionics repair	EL	--	--	--	--	3.3	1.4	0.0	--
Air controlman	GT	--	--	--	--	--	18.0	24.2	--
Air control maintenance	EL	--	--	--	--	--	21.2	30.6	--
Aircraft launch & recovery	GM	--	--	—	0.0	3.5	0.0	--	--
Air crew survival equipment	GM	--	--	--	--	0.0	2.7	0.0	--
Aviation operations (clerical)	CL	--	--	4.4	2.3	0.0	1.7	0.0	0.0
Aviation maintenance administration	CL	--	--	--	8.2	3.6	7.0	2.9	--
Aviation supply (mechanical)	CL	40.0	19.4	10.5	6.9	6.4	2.6	2.1	0.0

TABLE G-2 (Cont'd)

Course	Selector composite	Score on selector composite							
		60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139
Aerographers mate	GT	—	—	—	50.0	11.5	11.9	3.3	—
Small arms repair	GM	—	0.0	0.0	2.4	1.9	2.0	0.0	—
Tank crewman	FA	—	—	13.5	4.6	7.3	8.2	0.0	—
Field artillery fire control	FA	—	69.8	45.2	18.6	14.9	7.0	2.0	—
Ammunition storage	GT	—	—	3.4	0.0	0.0	3.9	—	—
Corrections specialist	GT	—	—	17.1	18.4	8.5	10.7	—	—
Military police	GT	—	21.7	36.9	21.7	16.0	9.8	4.1	0.0
Basic cannoneer	FA	—	37.9	26.8	12.8	7.1	3.6	—	—
Basic electricity and electronics	EL	—	—	—	—	38.8	16.1	5.5	0.0
Aviation machinist mate	GM	—	—	—	2.3	4.8	1.7	0.0	—
Avionics	EL	—	—	—	—	—	3.5	7.2	0.0

TABLE G-3

CUMULATIVE PERCENTAGE OF FAILURES FOR INDICATED CUT SCORE

Course	Selector composite	Score on selector composite							
		60	70	80	90	100	110	120	130
Basic supply stock clerk	CL	—	18.9	17.9	17.7	15.2	9.5	3.7	2.3
Personal financial records clerk	CL	--	--	--	--	8.7	6.6	0.9	0.0
Basic automotive mechanic	GM	—	3.9	3.6	3.0	2.6	2.2	0.9	--
Advanced automotive mechanic	GM	--	11.3	10.9	10.1	9.6	8.6	3.8	--
Basic baker	GT	--	--	—	5.6	3.2	1.9	--	--
Basic food service	GT	--	4.9	5.2	5.1	5.6	3.3	0.0	—
Basic combat engineer	GM	0.8	0.7	0.4	0.4	0.3	0.0	0.0	--
Basic electrician	EL	--	--	--	0.5	0.6	0.0	0.0	--
Electrical equipment repairman	EL	--	--	--	—	0.0	0.0	0.0	--
Basic engineer equipment mechanic	GM	3.9	3.6	3.0	3.8	4.6	2.4	--	--
Administrative clerk	CL	8.4	7.5	6.6	6.4	5.7	3.6	3.0	2.5
Personnel clerk	CL	--	--	--	4.0	4.6	4.2	0.0	--
Unit diary clerk	CL	--	--	--	8.2	7.0	6.9	3.9	--
Sea duty indoctrination	CO	--	15.4	14.8	13.4	12.6	10.9	8.3	—
Basic electronics	EL	--	--	—	31.6	28.4	22.5	10.6	0.0
Radio fundamentals	EL	--	--	--	--	--	5.9	3.5	--
Field radio operator	EL	—	3.7	3.7	2.6	1.0	1.1	1.4	--
Communications center man	CL	--	--	14.7	14.3	11.6	4.9	2.9	0.0
Air control electronic operator	GT	--	--	--	—	10.5	9.4	--	--
Infantry training	CO	0.5	0.5	0.5	0.6	0.4	0.1	0.4	0.0
Tracked vehicle repair	GM	—	—	7.0	6.2	6.6	4.2	--	--
Basic helicopter	GM	--	--	2.0	2.0	1.2	1.3	1.0	--
Aviation structural mechanic (safety equipment)	GM	--	--	--	—	0.9	0.0	0.0	--
Aviation structural mechanic (hydraulics)	GM	--	--	2.0	1.7	0.8	0.6	2.6	--
Aviation structural mechanic (structures)	GM	--	—	2.8	2.6	1.9	0.9	0.0	--
Aviation ordnance	GT	--	--	--	--	0.7	1.0	0.0	--
Aviation crash crew	GM	--	0.3	0.0	0.0	0.0	0.0	--	--
Avionics repair	EL	--	--	--	--	1.0	0.7	0.0	--
Air controlman	GT	--	--	--	--	--	18.4	18.8	--
Air control maintenance	EL	--	--	--	--	--	25.6	28.1	--
Aircraft launch & recovery	GM	--	--	--	1.2	1.7	0.0	--	--
Air crew survival equipment	GM	--	--	--	--	1.3	1.7	0.0	--
Aviation operations (clerical)	CL	--	--	1.3	1.0	0.6	1.1	0.0	--
Aviation maintenance administration	CL	--	--	--	5.5	4.6	5.2	2.6	--
Aviation supply (mechanical)	CL	7.1	6.5	5.7	4.9	4.3	2.4	1.9	--

TABLE G-3 (Cont'd)

Course	Selector composite	Score on selector composite							
		60	70	80	90	100	110	120	130
Aerographers mate	GT	—	—	—	9.5	8.8	8.1	2.5	0.0
Small arms repair	GM	—	1.3	1.4	1.9	1.6	1.3	0.0	—
Tank crewman	FA	—	—	7.6	5.3	5.7	4.3	0.0	—
Field artillery fire control	FA	—	22.1	17.4	11.9	9.4	5.3	1.9	—
Ammunition storage	GT	—	—	2.0	1.1	1.7	3.4	—	—
Corrections specialist	GT	—	—	13.4	11.1	8.3	7.9	—	—
Military police	GT	—	18.6	18.5	13.2	11.3	8.3	4.1	0.0
Basic cannoneer	FA	—	18.2	14.7	8.4	5.0	3.1	—	—
Basic electricity and electronics	EL	—	—	—	—	11.9	10.2	5.1	0.0
Aviation machinist mate	GM	—	—	—	2.6	2.3	1.2	0.0	—
Avionics	EL	—	—	—	—	—	5.3	6.1	0.0

TABLE G-4

FY 1980 COURSE FAILURE RATES

Course title	Failure rate (percent)
Air traffic controller	30.0
Advanced auto mechanic	14.5
Air control electronics operator	27.6
Machinists mate	8.0
Aerographers mate	20.4
Aviation structural mechanics	
safety equipment	5.0
hydraulics	6.0
structures	8.0
Aviation ordnance	12.0
Airborne radio operator	24.0
Aviation support equipment, electrical	4.0
Aviation support equipment, mechanical	6.0
Air support electronics operator	20.0
Aviation crash crew	3.0
Aviation maintenance administration	--
Basic electricity and electronics	18.0
Basic helicopter maintenance	4.0
Cryogenic equipment technician	15.0
HAWK missile fire control crewman	5.6
HAWK launcher and mechanical systems repair	--
Aircraft launch and recovery equipment	1.0
Marine aviation supply, mechanized	--
Aviation operations clerk	--
Missile system maintenance fundamentals	6.7
Aerial navigator	35.0
Aircrew survival equipment	4.3
Turboprop mechanic	8.9
REDEYE gunner	6.1
Ammunition storage	3.7
Assault amphibian crewman	--
Artillery ballistic meteorology	5.3
Marine artillery scout observer	22.0
Aviation support equipment technician (Elec)	4.0
Audio/TV production specialist	16.7
Basic automotive mechanic	13.2
Artillery repair	1.9
Administrative clerk	3.5
Basic baker	4.9
Basic packing and preservation man	--
Personal financial records clerk	3.1
Basic electronics	24.9
Basic electricity and electronics	18.0

TABLE G-4 (Cont'd)

Course title	Failure rate (percent)
Metal body repair	14.0
Basic travel clerk	4.7
Fabric repairman	11.6
Basic cartography	25.8
Basic combat engineer	2.6
IBM system 360 OS, COBOL	3.9
Construction drafting	8.3
Communications center man	8.8
Construction surveying	11.8
Corrections specialist	4.2
Cryptographic technician, O	15.3
Cryptographic technician, R	28.0
Cryptographic technician, T	47.4
Defense language institute	--
Basic engineer equipment mechanic	4.7
Engineering equipment operator	1.1
Electrical equipment repairman	7.1
Basic electrician	2.7
Basic amphibious embarkation man	21.0
Financial accounting clerk	11.8
Field artillery radar crewman	3.0
Field artillery fire control	25.0
Fire control instrument repair	10.4
Basic food service man	10.5
Basic lithographic processes	--
Field radio operator	8.8
Geodetic surveying	24.2
Graphics specialist	11.1
HAWK launcher and mechanical systems repair	--
Intelligence specialist	5.0
Information specialist (broadcaster)	36.9
Information specialist (journalist)	21.4
Small arms repair	3.0
Laundry and bath specialist	1.0
Legal services man	3.7
Marine barracks	--
Basic metal worker	19.9
Military police	16.9
Offset duplicating	9.8
Offset printing	30.0
Office machine repair	4.2
IBM systems 360, OS, operations	4.0
Continuous photoprocessing specialist	21.4
Basic plumbing and water supply man	3.5

TABLE G-4 (Cont'd)

Course title	Failure rate (percent)
Postal operations	9.3
Quartermaster equipment repair	7.2
Basic refrigeration mechanic	2.0
Machinist	37.9
Sea duty	21.1
Shore fire control party	2.5
Still photographic specialist	10.5
Subsistence supply man	11.4
Basic supply stock control man	10.4
Tank crewman	5.8
Assault amphibian repairman	15.4
Tracked vehicle repair, artillery	--
Tracked vehicle repair, tank	1.6
Infantry training	5.2

APPENDIX H

FACTOR ANALYSIS

APPENDIX H

FACTOR ANALYSIS

The factor analysis reported here was done using the standard routines in the SPSS* software package [H-1]. The data were obtained from a random sample of 23,061 Marine Corps recruits tested on ASVAB 6/7 at recruit depots in 1977.

Each variable is assumed to be made up of a unique part plus shared common factors. The assumptions may be expressed as

$$x_j = a_{j1}F_1 + a_{j2}F_2 = \ldots + a_{jm}F_m + d_jU_j ,$$

where:

- n = number of original variables
- j = 1, 2, ... n
- x_j = variable j in standardized form
- F_m = the m^{th} common factor
- U_j = unique factor for variable j
- a_{ji} = standardized multiple regression coefficient of variable j on factor i (also called the factor loading)
- d_j = standardized regression coefficient of variable j on unique factor j

The specific method used is referred to as "principal factoring with iterations." The steps involved are summarized as follows:

1. Carry out principal factoring using unaltered (unity on diagonals) correlation matrixes in table H-1 as input. As many factors are identified as there are variables in the data set.

2. The number of factors to be extracted is taken as the number of factors in step 1 that have eigenvalues equal to or greater than 1.0. This criterion ensures that only factors accounting for at least the amount of variance of a single variable will be treated as significant.

3. The main diagonals in the correlation matrixes are replaced by squared multiple correlations (SMC) as initial estimates of the communality of the relevant variable with all other variables in the set.

4. The number of factors determined in step 2 are extracted.

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* Statistical Package for the Social Sciences.

TABLE H-1

CORRELATION COEFFICIENTS FOR ASVAB TESTS

	GI	NO	AO	WK	AR	SP	MK	EI
GI	1.00000	0.28618	0.44915	0.54280	0.43539	0.27354	0.42646	0.52237
NO	0.28618	1.00000	0.37597	0.30550	0.48937	0.19933	0.52045	0.28238
AO	0.44915	0.37597	1.00000	0.10749	0.21181	0.15143	0.23834	0.10874
WK	0.54280	0.30550	0.10749	1.00000	0.52153	0.27598	0.49207	0.51459
AR	0.43539	0.48937	0.21181	0.52153	1.00000	0.37541	0.67987	0.46262
SP	0.27354	0.19933	0.15143	0.27598	0.37541	1.00000	0.36898	0.38078
MK	0.42646	0.52045	0.23834	0.49207	0.67987	0.36898	1.00000	0.46899
EI	0.52237	0.28238	0.10874	0.51459	0.46262	0.38078	0.46899	1.00000
MC	0.48856	0.29032	0.13662	0.47238	0.52913	0.51286	0.50419	0.60868
GS	0.54701	0.32393	0.11489	0.65389	0.53812	0.33907	0.54607	0.60116
SI	0.49560	0.20882	0.06336	0.37533	0.38024	0.34497	0.32437	0.60362
AI	0.47775	0.16703	0.01200	0.36045	0.36332	0.30151	0.29344	0.59889
CM	0.15229	0.02501	0.00491	0.02025	0.10185	0.16650	0.03838	0.30130
CA	0.05406	0.20699	0.13482	0.17504	0.18355	0.04505	0.21014	0.09211
CE	0.11078	0.19013	0.11502	0.14512	0.25213	0.18579	0.29723	0.25332
CC	0.36405	0.20977	0.09491	0.31681	0.28588	0.20425	0.24550	0.33122

	SI	AI	CM	CA	CE	CC	MC	GS
GI	0.49560	0.47775	0.15229	0.05406	0.11078	0.36405	0.48856	0.54701
NO	0.20882	0.16703	0.02501	0.20699	0.19013	0.20977	0.29032	0.32393
AO	0.06336	0.01200	0.00491	0.13482	0.11502	0.09491	0.13662	0.11489
WK	0.37533	0.36045	0.02025	0.17504	0.14512	0.31681	0.47238	0.65389
AR	0.38024	0.36332	0.10185	0.18355	0.25213	0.28588	0.52913	0.53812
SP	0.34497	0.30151	0.16650	0.04505	0.18579	0.20425	0.51286	0.33907
MK	0.32437	0.29344	0.03838	0.21014	0.29723	0.24550	0.50419	0.54607
EI	0.60362	0.59889	0.30130	0.09211	0.25332	0.33122	0.60868	0.60116
MC	0.59271	0.55666	0.27294	0.04414	0.21782	0.35459	1.00000	0.59528
GS	0.50087	0.46331	0.12173	0.14398	0.21702	0.33957	0.59528	1.00000
SI	1.00000	0.85698	0.38907	-0.03511	0.11243	0.37676	0.59271	0.50087
AI	0.85698	1.00000	0.46851	-0.02599	0.11571	0.31353	0.55666	0.46331
CM	0.38907	0.46851	1.00000	0.10268	0.39615	0.34293	0.27294	0.12173
CA	-0.03511	-0.02599	0.10268	1.00000	0.43456	0.10277	0.04414	0.14398
CE	0.11243	0.11571	0.39615	0.43456	1.00000	0.18008	0.21782	0.21702
CC	0.37676	0.31353	0.34293	0.10277	0.18008	1.00000	0.35459	0.33957

5. The variances accounted for by these factors become new communality estimates.

6. Diagonal elements of the correlation matrix are replaced by the new communality estimates from step 5, and the process is repeated until the differences between successive estimates of the communality become negligible.

7. After the iterative process in step 6 is terminated, the selected factors are rotated orthogonally (Varimax rotation)* to produce a simple representation of the factors. The resulting factor loadings are given in table H-2.

The factor loadings in table H-2 could be used to express the input variables in terms of the extracted factors. The factor score coefficients for the individual ASVAB tests are shown in table H-3. These coefficients could be used to estimate the factors in terms of the variables.

An examination of table H-3 discloses that factor 1 draws heavily on the SI, AI, and CM tests. These are all shop-oriented tests; hence, we identify factor 1 as the "shop" factor. Factor 2 is seen to have large factor score coefficients for the mathematically oriented NO, AR, and MK tests. Hence, we call factor 2 the "math" factor. Factor 3 is seen to have large positive coefficients for the WK and GS tests; hence, we identify this factor as the "verbal" factor. Factor 4 has large coefficients for CA and CE. These two tests are interest inventories and attempt to measure attentiveness and electronics interest, respectively. We somewhat arbitrarily call this factor an "attitudinal" factor.

The variance in scores on each test that may be attributed to each factor is given by the square of the rotated factor loading shown in table H-2. Variance attributed to the common factors (communality), the unique factors (specificity), and error are calculated as shown in table H-4.

* Oblique rotations were also tried and similar results were obtained.

TABLE H-2

ROTATED FACTOR LOADINGS[a,b]
FOR INDIVIDUAL ASVAB TESTS

Test	Factor			
	Factor 1	Factor 2	Factor 3	Factor 4
GI	0.29868	0.12946	0.62523	-0.00793
NO	0.05064	0.63935	0.23364	0.13060
AD	0.01309	0.45882	0.00133	0.08465
WK	0.06680	0.15161	0.77660	0.12101
AR	0.17924	0.53673	0.51989	0.13351
SP	0.30669	0.29308	0.28622	0.02412
MK	0.09940	0.59009	0.51460	0.18016
EI	0.48970	0.17931	0.57682	0.07245
MC	0.49852	0.30401	0.53012	-0.00724
GS	0.23393	0.19511	0.75372	0.11221
SI	0.65588	0.11588	0.44458	-0.11572
AI	0.68441	0.04271	0.41086	-0.07865
CM	0.74933	-0.07464	-0.09317	0.32880
CA	-0.06628	0.14771	0.09564	0.57031
CE	0.23725	0.15436	0.05837	0.72176
CC	0.36224	0.11147	0.28775	0.13518

[a]Four factors were found. They had initial unrotated eigenvalues of 6.03, 1.78, 1.48, and 1.03, respectively, and account for 64.5 percent of the total observed variance.
[b]This matrix is also referred to as the "factor matrix."

TABLE H-3

FACTOR SCORE COEFFICIENTS
FOR INDIVIDUAL ASVAB TESTS

Test	Factor			
	Factor 1	Factor 2	Factor 3	Factor 4
GI	0.00760	-0.08003	0.16272	-0.02306
NO	-0.01603	0.36379	-0.09310	-0.00592
AD	0.01051	0.20759	-0.08566	-0.00968
WK	-0.17502	-0.17394	0.37351	0.11218
AR	-0.02724	0.25118	0.04486	0.00151
SP	0.04808	0.07998	-0.01693	-0.03193
MK	-0.07521	0.33357	0.05187	0.03570
EI	0.10197	-0.03241	0.11213	-0.00384
MC	0.15851	0.11925	0.03914	-0.11014
GS	-0.08211	-0.13201	0.31790	0.07319
SI	0.26534	-0.00060	0.02973	-0.17959
AI	0.25113	-0.07834	0.04121	-0.13711
CM	0.44674	-0.07889	-0.23127	0.24326
CA	-0.06600	-0.00559	0.01916	0.27503
CE	0.02671	-0.02830	-0.04385	0.52968
CC	0.04169	0.00046	0.01789	0.02657

TABLE H-4

FACTOR ANALYSIS OF ASVAB INDIVIDUAL TESTS

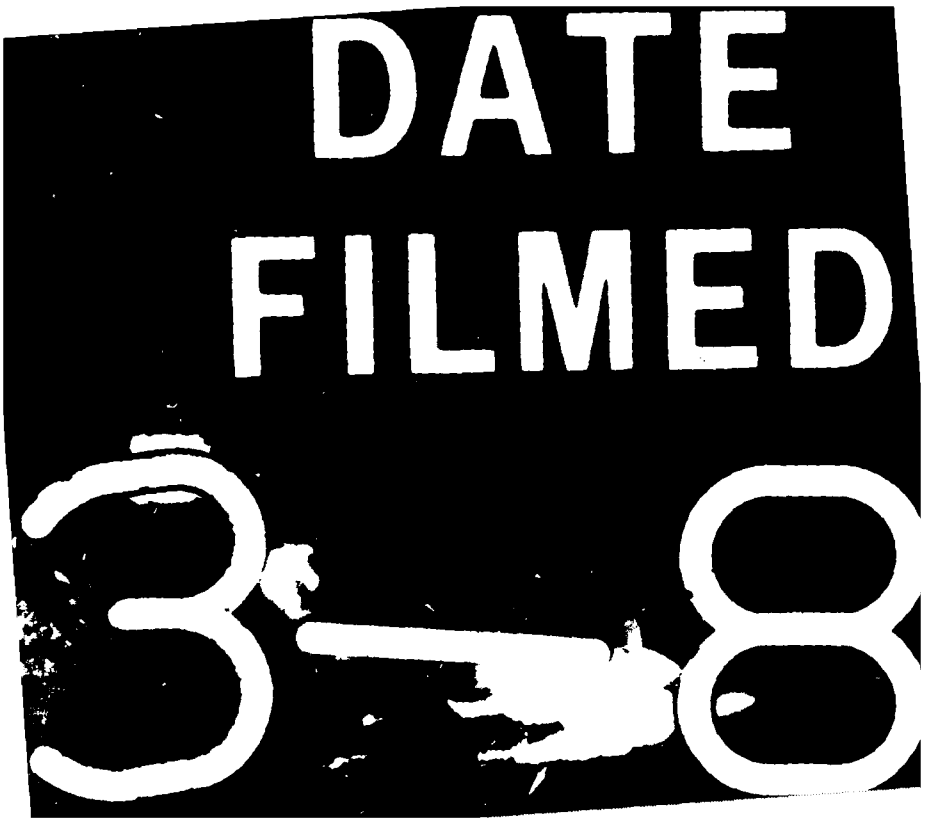
	Squared rotated factor loadings for factors 1 through 4:				Sources of variance			
Test	(1)	(2)	(3)	(4)	Communality[a]	Reliability[b]	Specificity[c]	Error[d]
GI	.09	.02	.39	.00	.50	.74	.24	.26
NO	.00	.41	.05	.02	.48	.87	.39	.13
AD	.00	.21	.00	.01	.22	.80	.58	.20
MK	.00	.02	.60	.01	.65	.91	.26	.09
AR	.03	.29	.27	.02	.61	.85	.24	.15
SP	.09	.09	.08	.00	.26	.79	.52	.22
MK	.01	.35	.26	.03	.66	.83	.17	.18
EI	.24	.03	.33	.01	.61	.86	.25	.15
MC	.25	.09	.28	.00	.62	.80	.18	.20
GS	.05	.04	.57	.01	.67	.80	.13	.20
SI	.43	.01	.20	.01	.65	.84	.18	.17
AI	.47	.00	.17	.01	.65	.85	.20	.15
CM	.56	.01	.01	.11	.68	.84	.16	.16
CA	.00	.02	.01	.33	.36	.53	.17	.47
CE	.06	.02	.00	.52	.60	.80	.20	.20
CC	.13	.01	.08	.02	.24	.65	.40	.35

[a]Communality = sum of squared factor loadings.
[b]Reliabilities for tests GI through AI were taken as the mean values of estimates reported separately by [H-2] for form 6 and 7. Reference H-2 calculated these reliabilities using the Kuder-Richardson Formula 20, except for the NO and AD tests for which they used the test/retest method. Reliabilities for the CM, CA, CE, and CC tests were calculated by us using the Kuder-Richardson Formula 21, hence, the reliabilities for these four tests are probably underestimated.
[c]Specificity = reliability - communality.
[d]Error = 1 - reliability.

REFERENCES

[H-1] N.H. Nie et al. "Statistical Package for the Social Sciences." New York: McGraw-Hill: 1975

[H-2] Air Force Human Resources Laboratory, AFHRL-TR-76-87, "Development of the Armed Servcies Vocational Aptitude Battery, Forms 5, 6, and 7," H.E. Jensen, I.H. Massey, and L.D. Valentine, Jr., Unclassified, Dec 1976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